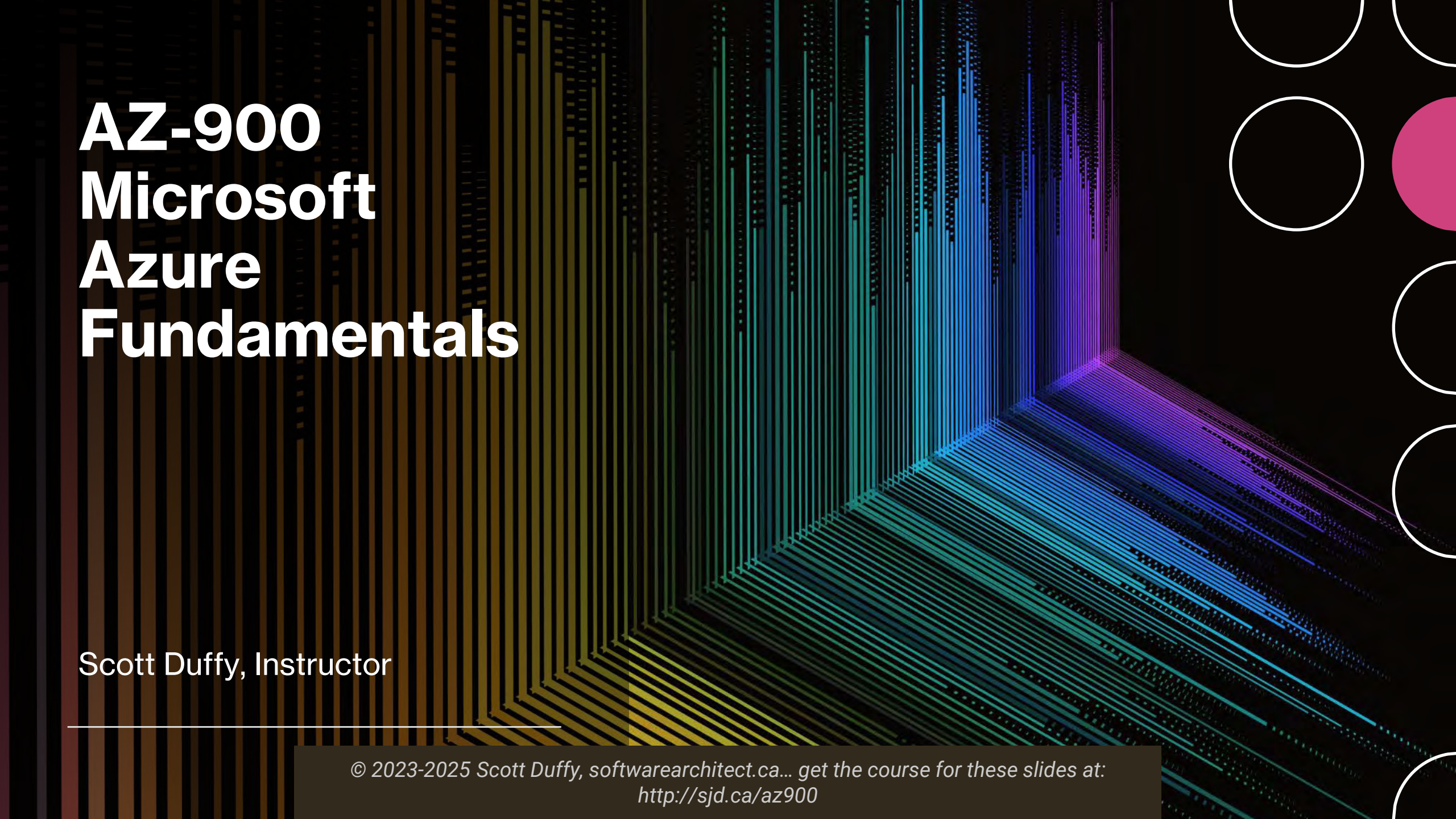

AZ-900 Microsoft Azure Fundamentals

Scott Duffy, Instructor

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Course up-to-date as of October 2025

Will always be up-to-date

Course version 3.6

Updated in 2025

Microsoft Azure Fundamentals

“ foundational level knowledge of cloud services and how those services are provided with Microsoft Azure ”

Microsoft Azure Fundamentals

- Candidates with non-technical backgrounds
- Candidates with a technical background who have a need to validate their foundational level knowledge around cloud services

Microsoft Azure Fundamentals

- Describe cloud concepts
- Describe Azure architecture and services
- Describe Azure management and governance

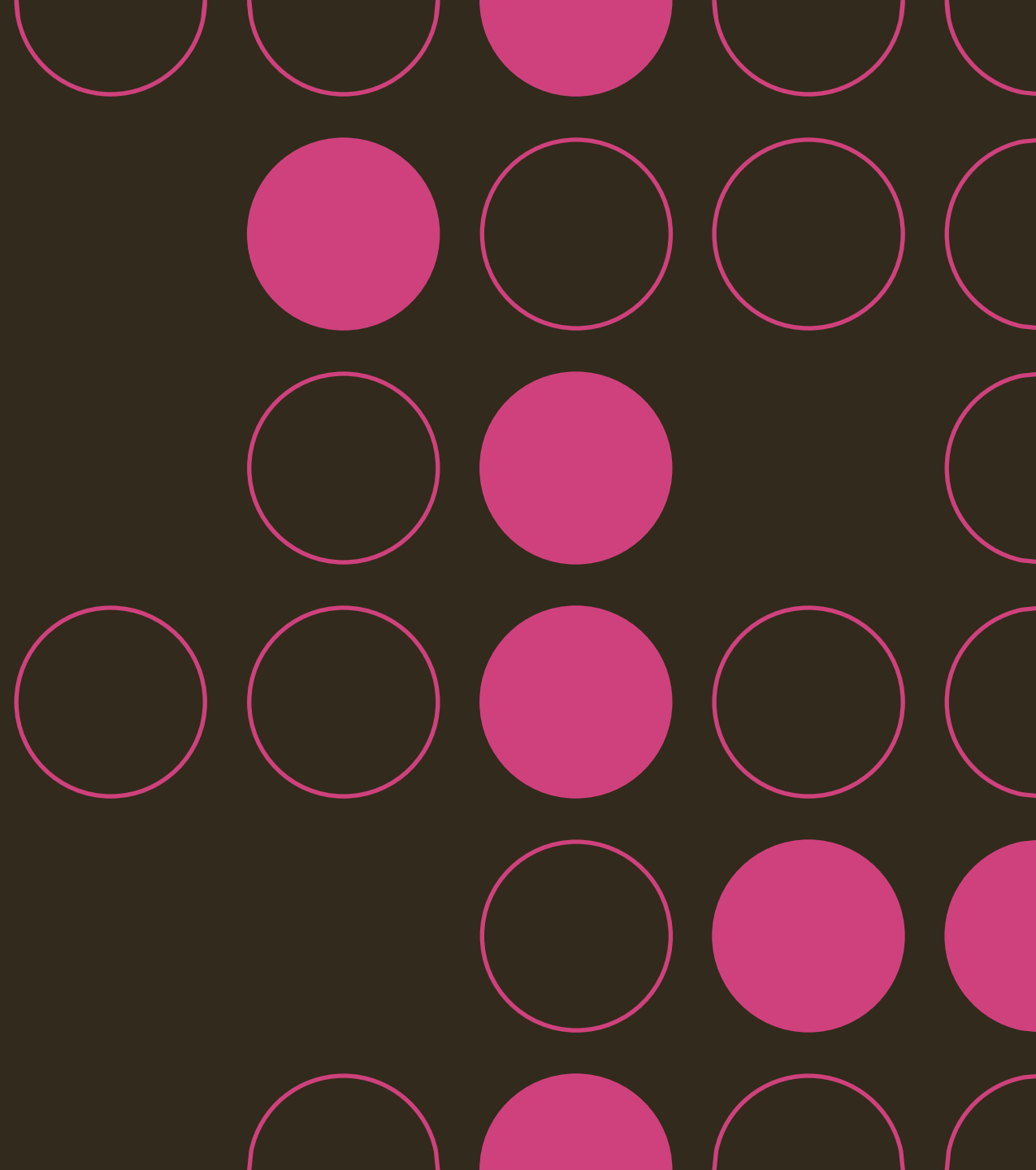
Be Prepared!



This course will completely prepare you to pass the AZ-900 exam.

Taking the exam is optional, of course.

This course will give you a solid foundation in cloud concepts and Microsoft Azure.





What is the Cloud?



There is no spoon.

- “The cloud” is just someone else’s computer.

What makes Cloud Computing special?

The ability to rent computing resources - on demand

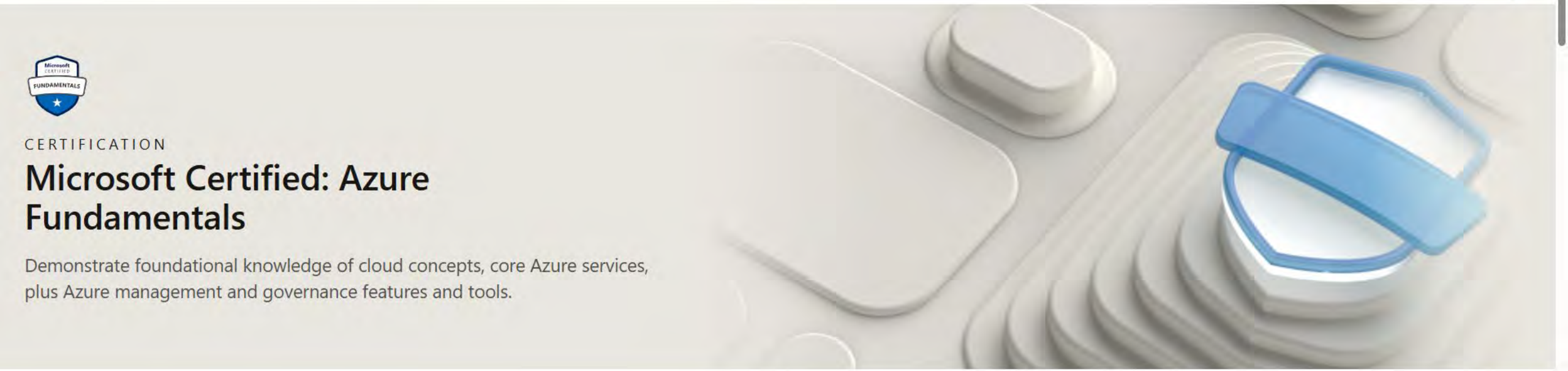




Computing Resources...

- Windows and Linux Servers
- Unlimited File
- Databases
- Message Queues
- Content Delivery Network
- Batch Processing Jobs

1,000+ different Azure services



CERTIFICATION

Microsoft Certified: Azure Fundamentals

Demonstrate foundational knowledge of cloud concepts, core Azure services, plus Azure management and governance features and tools.

At a glance

Level
Beginner

Product
Azure

Role
Administrator

Last Updated
10/30/2025

Jump to

Free study resources within this course:

- Free PDF Study Guide
- Download the slides and MP3 audio if you like to study offline
- 50 question practice test

Located in the last section of the course.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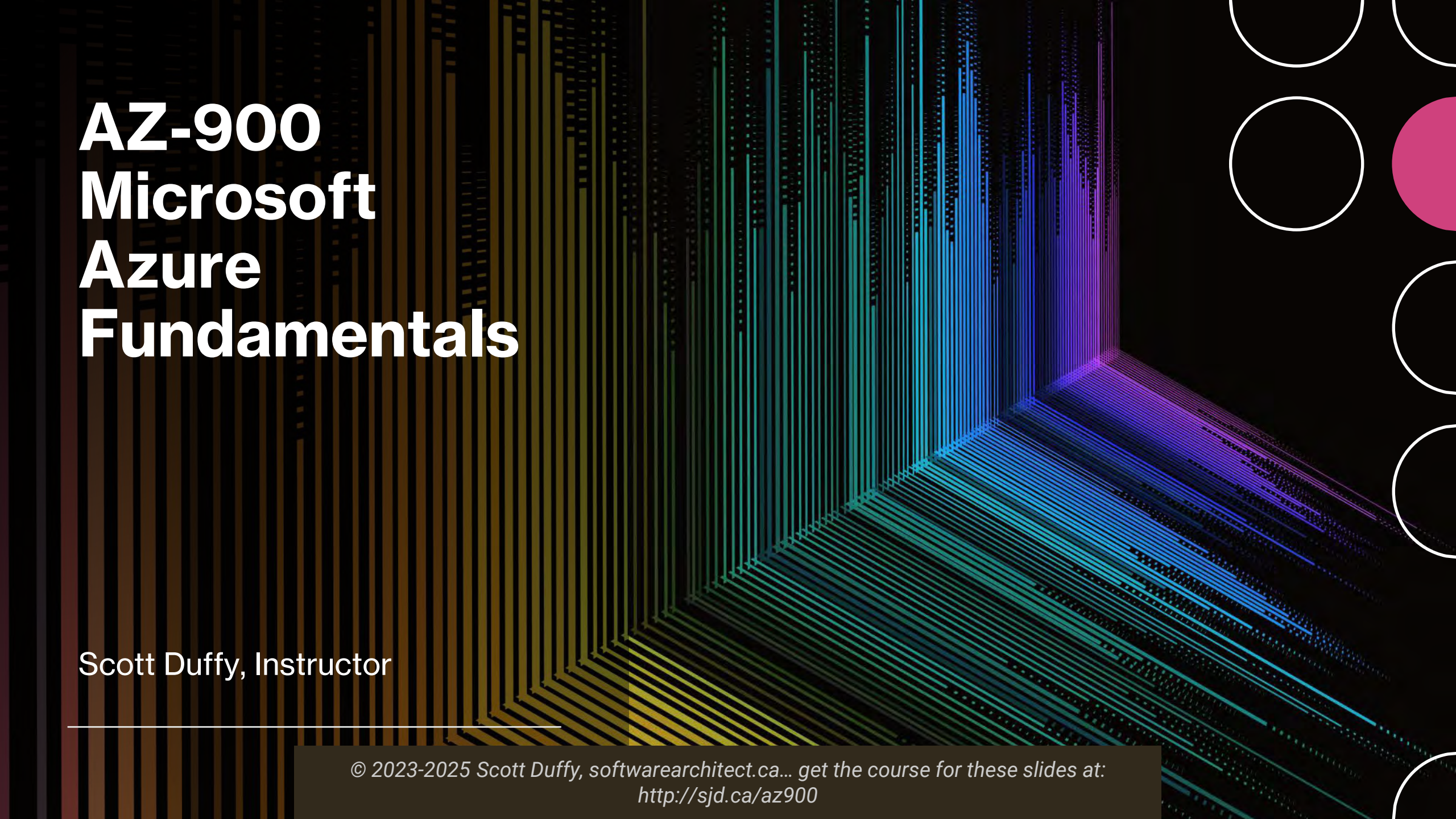

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Describe Cloud Concepts (25-30%)



Describe cloud concepts (25–30%)

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- Identify appropriate use cases for each cloud model
- Describe the consumption-based model
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- Describe serverless

Describe the benefits of using cloud services

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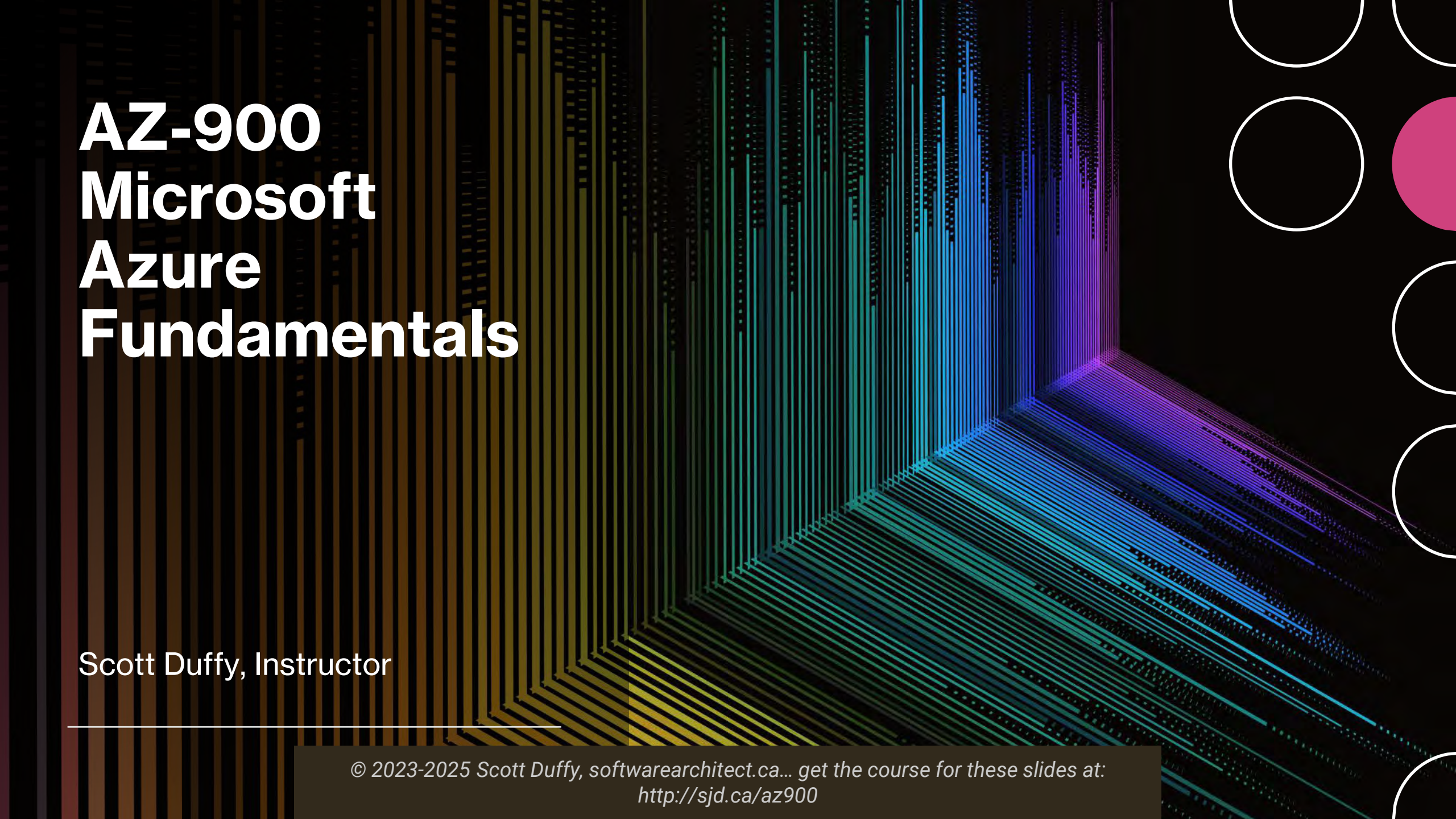

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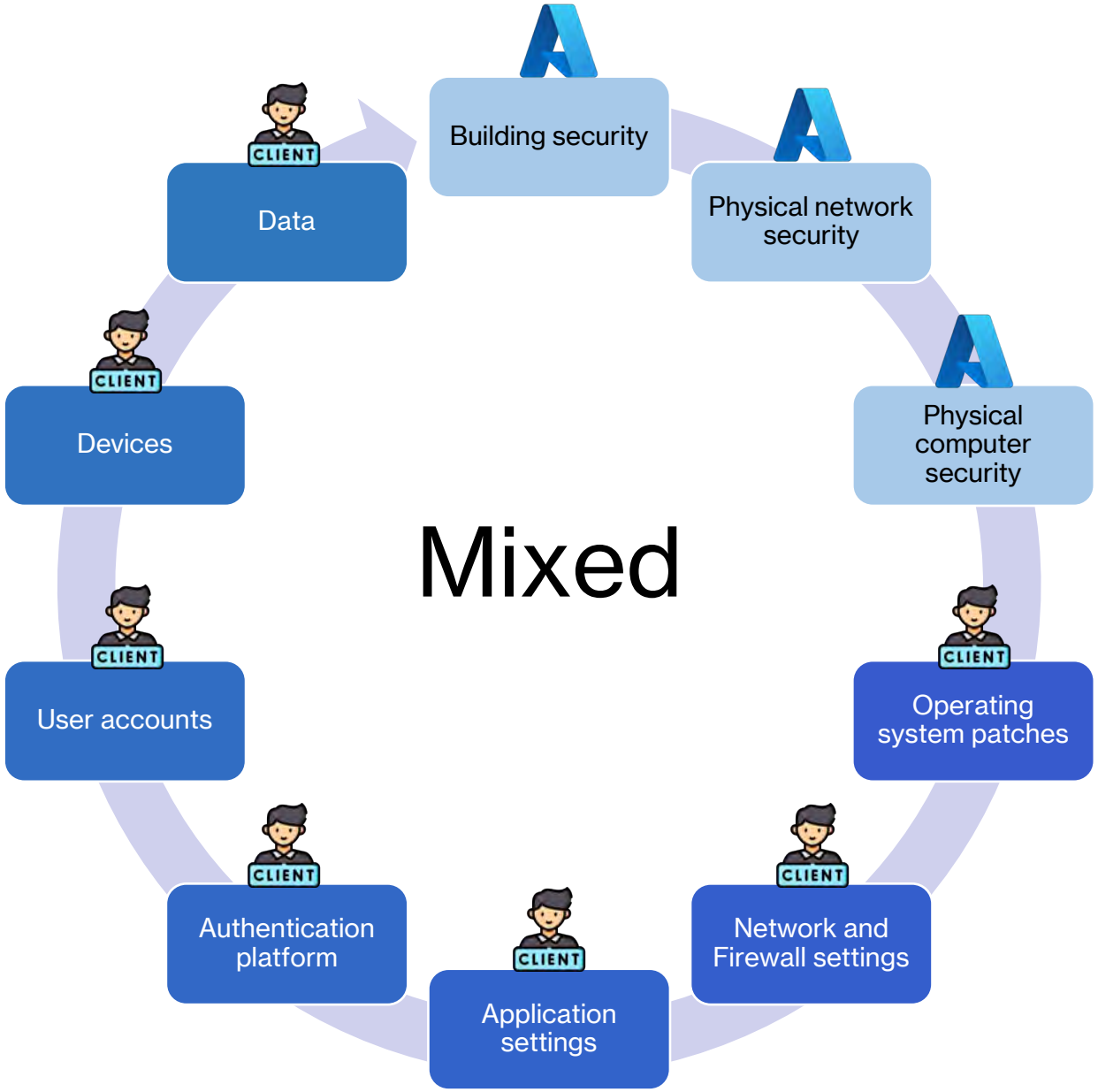
Shared Responsibility Model

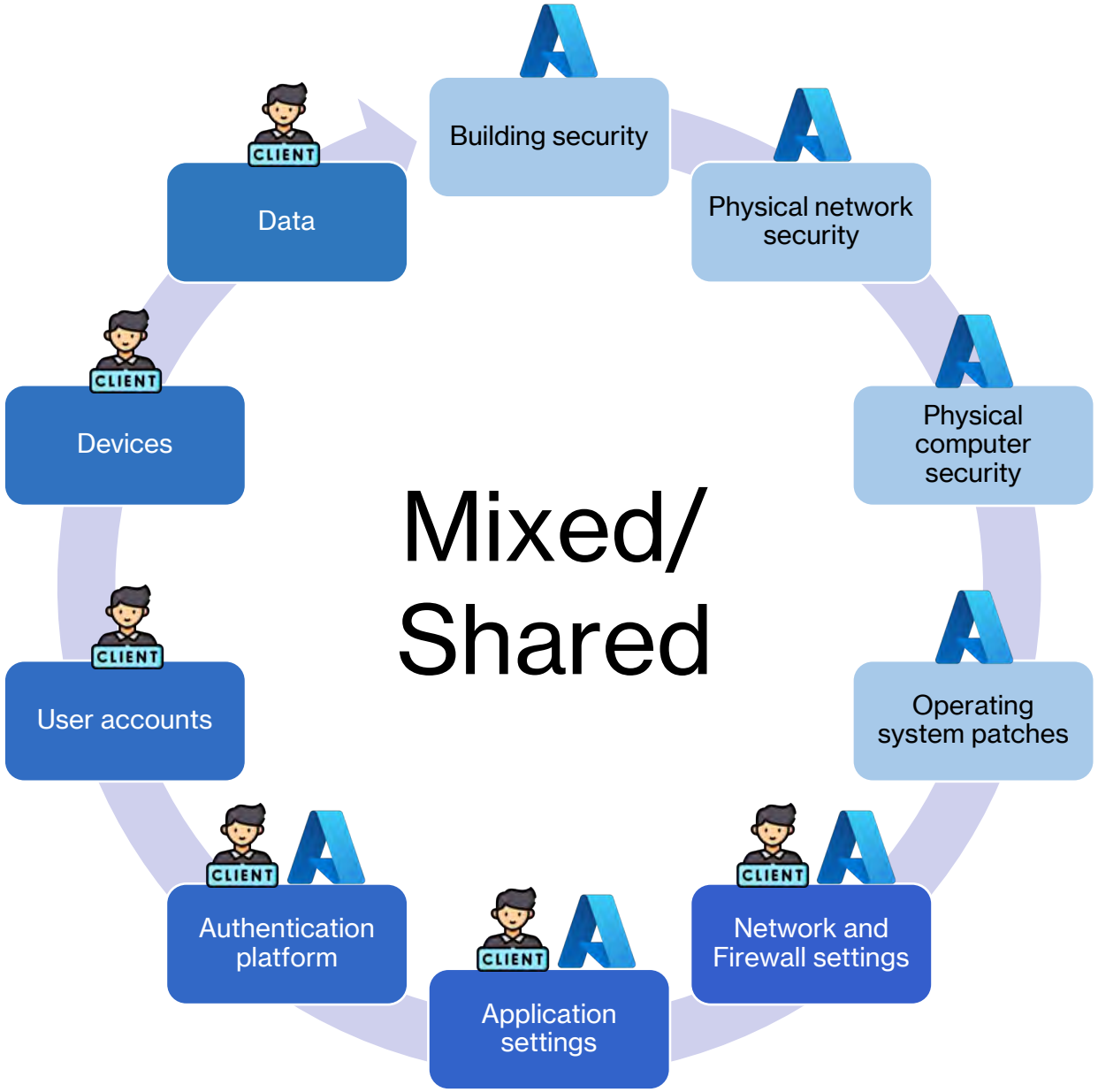
On Premises Responsibility:



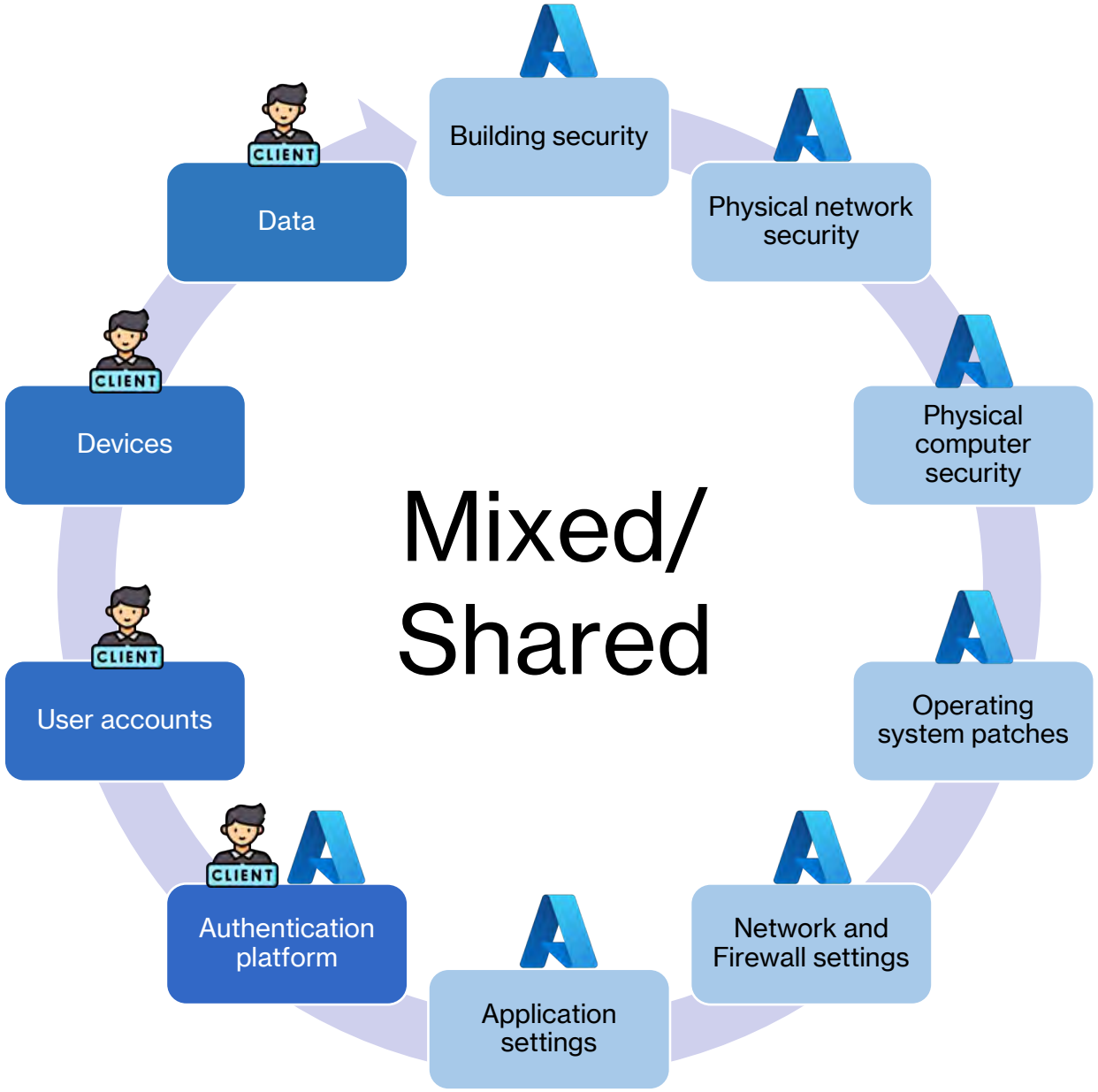
Cloud Virtual Machine Responsibility:



Cloud App Service Responsibility:



Cloud SaaS Responsibility:



Shared responsibility model

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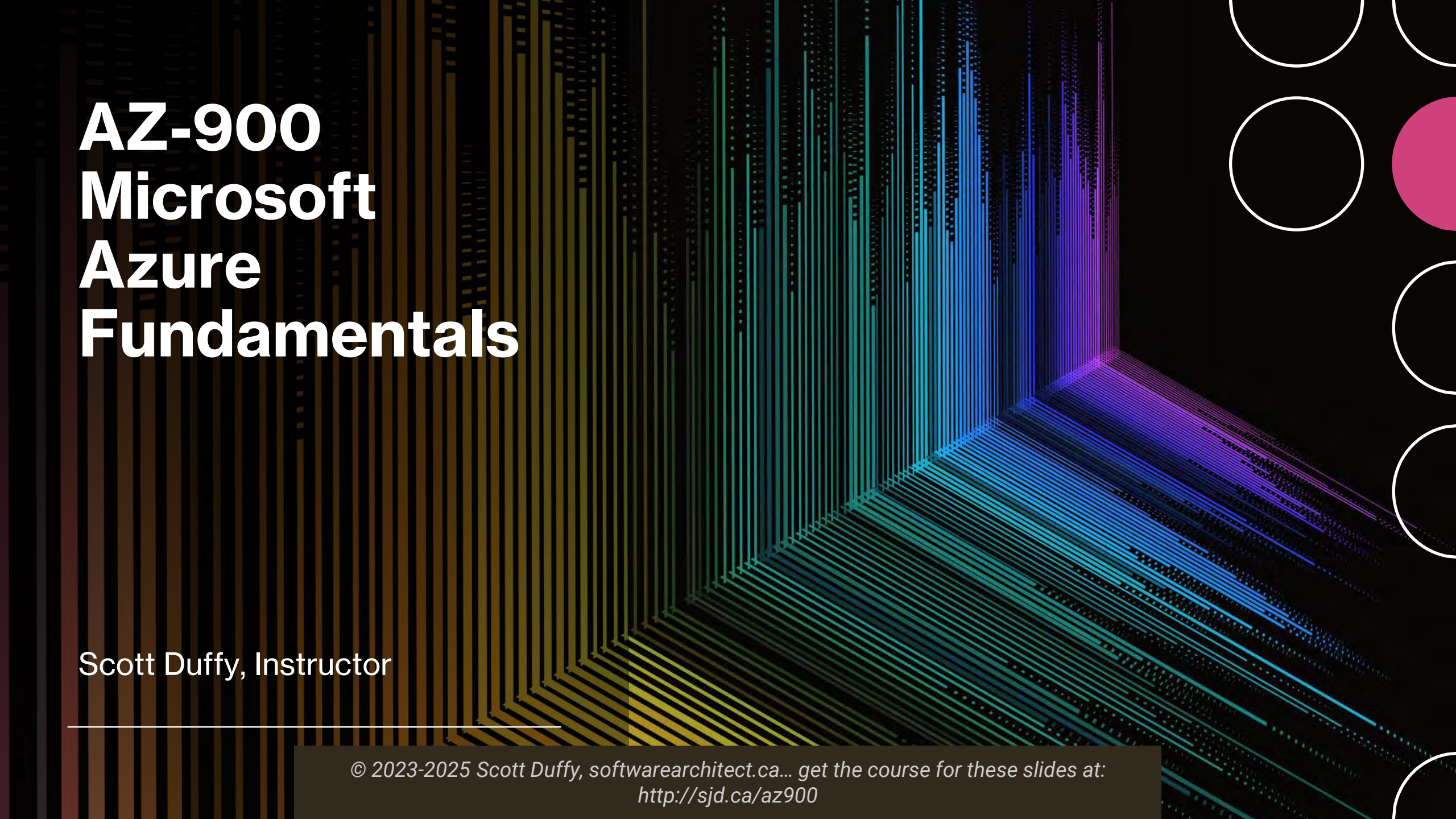

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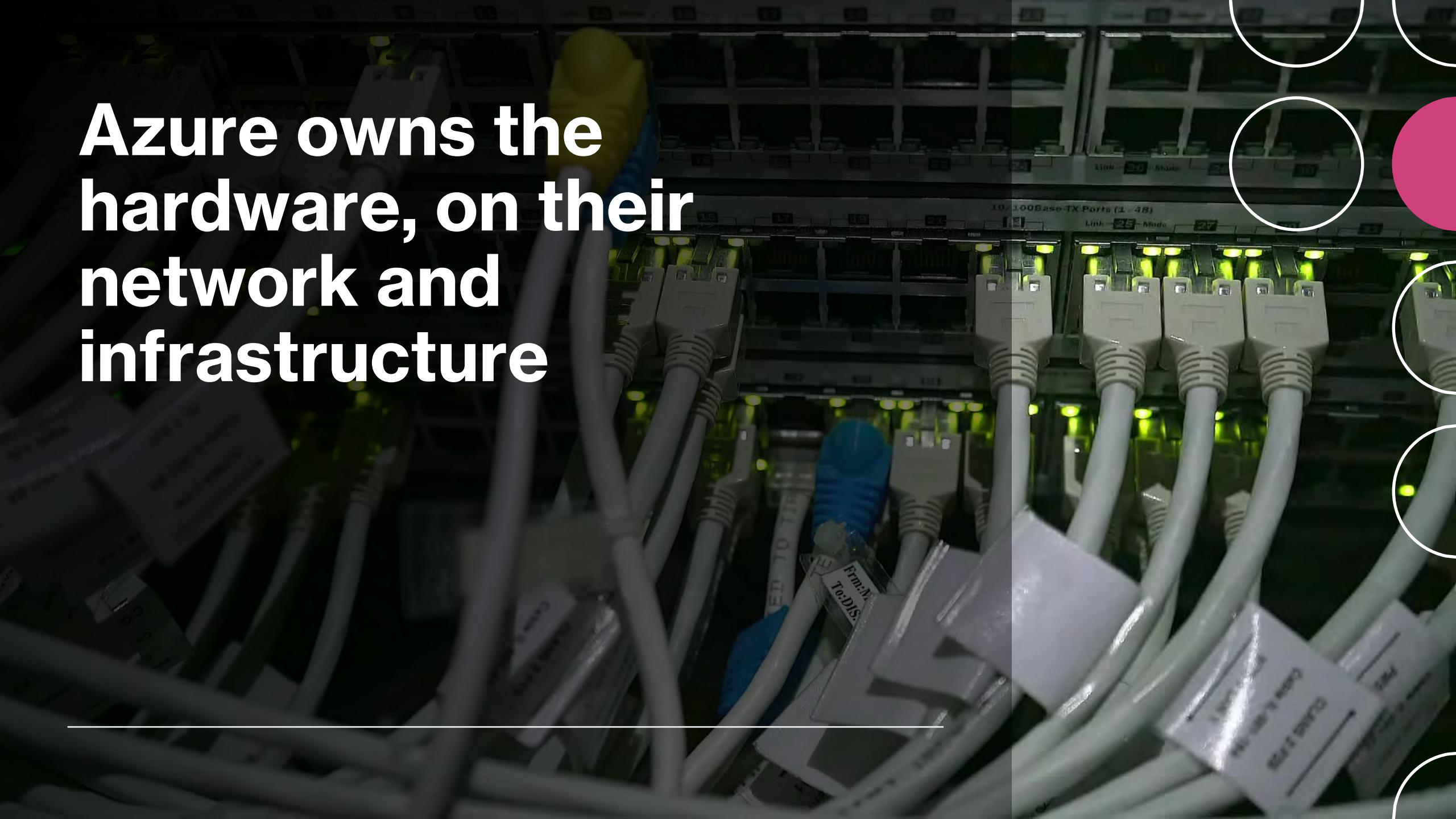
Public cloud

“The public cloud is defined as computing services offered by third-party providers over the public Internet, making them available to anyone who wants to use or purchase them.”

Azure owns the hardware, on their network and infrastructure



Private cloud

“The private cloud is defined as computing services offered either over the Internet or a private internal network and only to select users instead of the general public.”

Azure Government Cloud



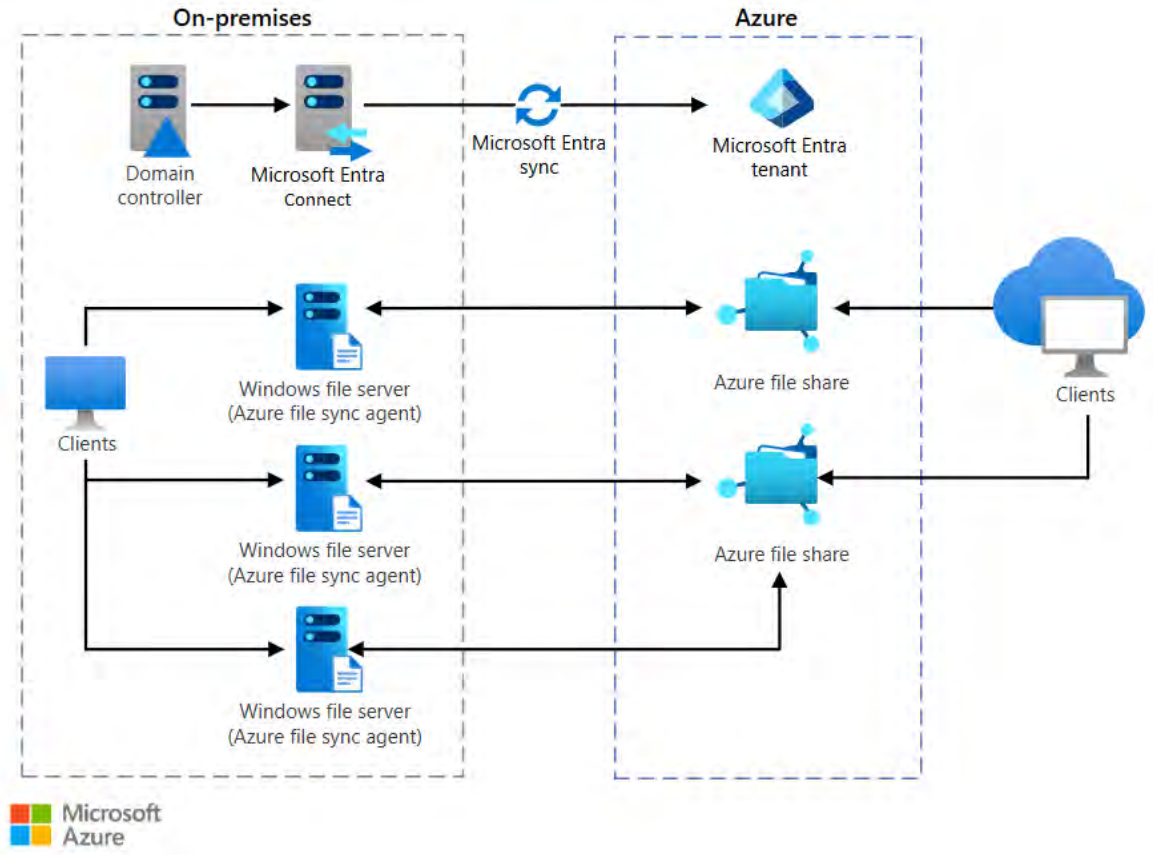


Azure Local (formerly Azure Stack HCI)

Hybrid cloud

“A hybrid cloud... is a computing environment that combines a private cloud with a public cloud.”

Combination of public and private clouds; scale private infrastructure to the cloud



Compare and Contrast

Public vs private vs hybrid

Comparison

	Public Cloud	Private Cloud	Hybrid Cloud
Cost	Operational Expenditure (OpEx)	Capital Expenditure (CapEx)	Blend
Ownership	Azure	You	Both
Access	General Public	Restricted	Combination
Scalability	Massive/Elastic	Limited	Flexible
Core Value	Speed, Cost, Efficiency	Control, Security, Compliance	Flexibility and Control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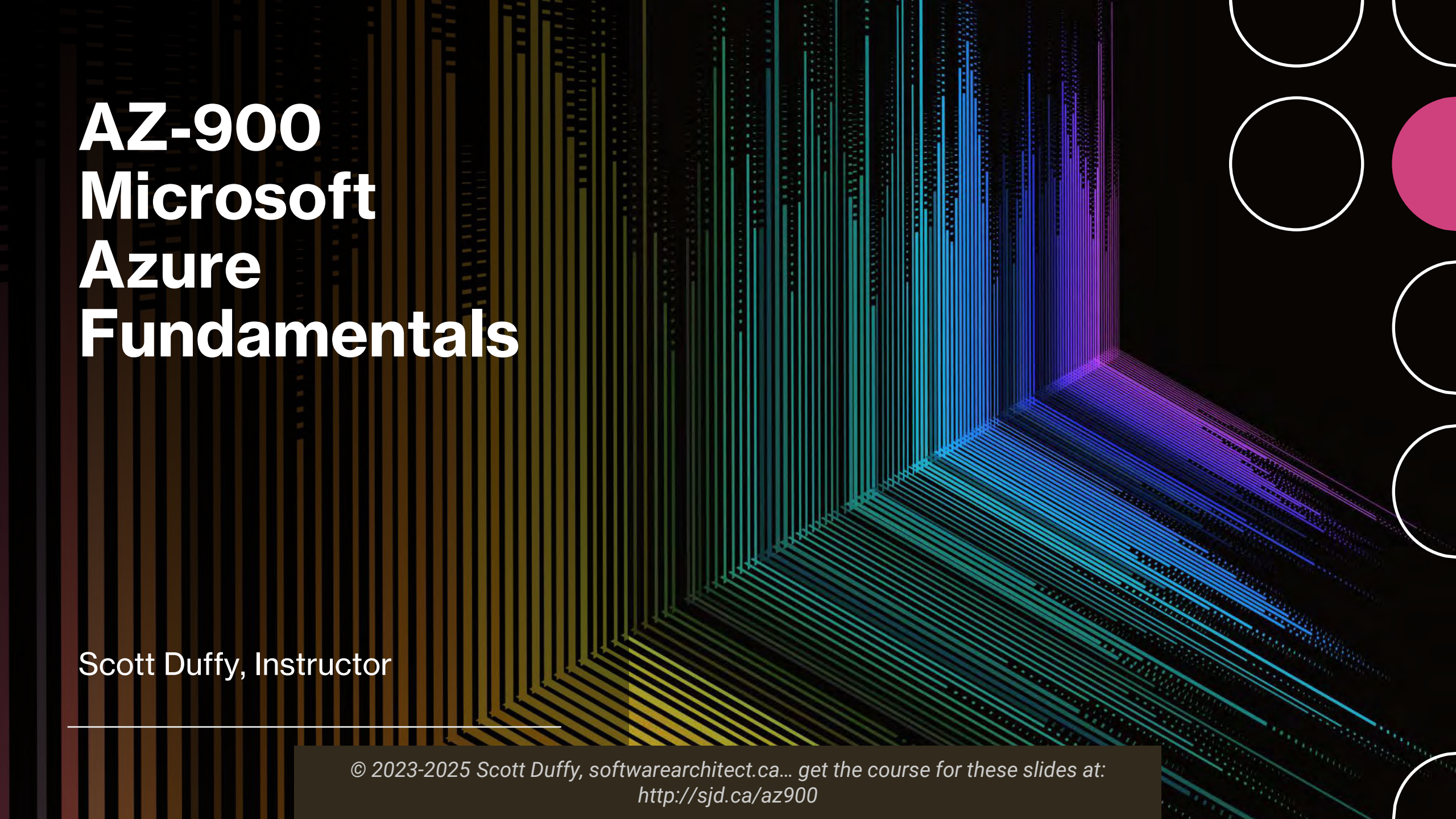

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Cloud Pricing

Complexity

Cloud pricing can be complicated



Can Be Considered a Downside to Cloud Computing

- Difficult to predict your monthly bill
- Difficult to understand in advance what a service will really cost
- Possibility for big savings but you lose predictability

Factors Affecting VM Pricing

- Geographical Region
- Operating System SKU / License
- Instance Size
- Disk Type / Size
- Bandwidth
- Backup
- Reservation / Savings Plan
- Support Agreement

Factors Affecting Cosmos DB Pricing



API Choice



Region / Regions



Standard Model / Serverless



Number of Operations per Second



Consumed



Optional Dedicated Gateway



Backup

Free Services

- 55+ free services that can be used as part of your solution
- Some paid services have free tiers
- Some have limits



55+ Free Services

Take advantage of free products

These products are free up to the specified monthly amounts. Some are always free to all Azure customers, and some are free for 12 months to new customers only.

Azure service	Description	Type	Free monthly amount	Free period
Advisor	Get personalized recommendations and best practices for Azure.	Management and governance	Unlimited	Always
API Management	Manage APIs across all platforms with a hybrid, multicloud platform.	Integration	1 million monthly calls free with Consumption tier	Always
App Configuration	Store and manage configurations for all your Azure apps.	Developer tools	1,000 requests per day with 10 MB storage	Always
App Service	Quickly create powerful apps for any platform or device using your choice of tools including Node.js and PHP.	Compute	10 web, mobile, or API apps with 1 GB storage 1 hour per day	Always
Archive Storage	Store and manage rarely accessed data with	Storage	10 GB LRS storage, 10 GB LRS or GRS write	12 months



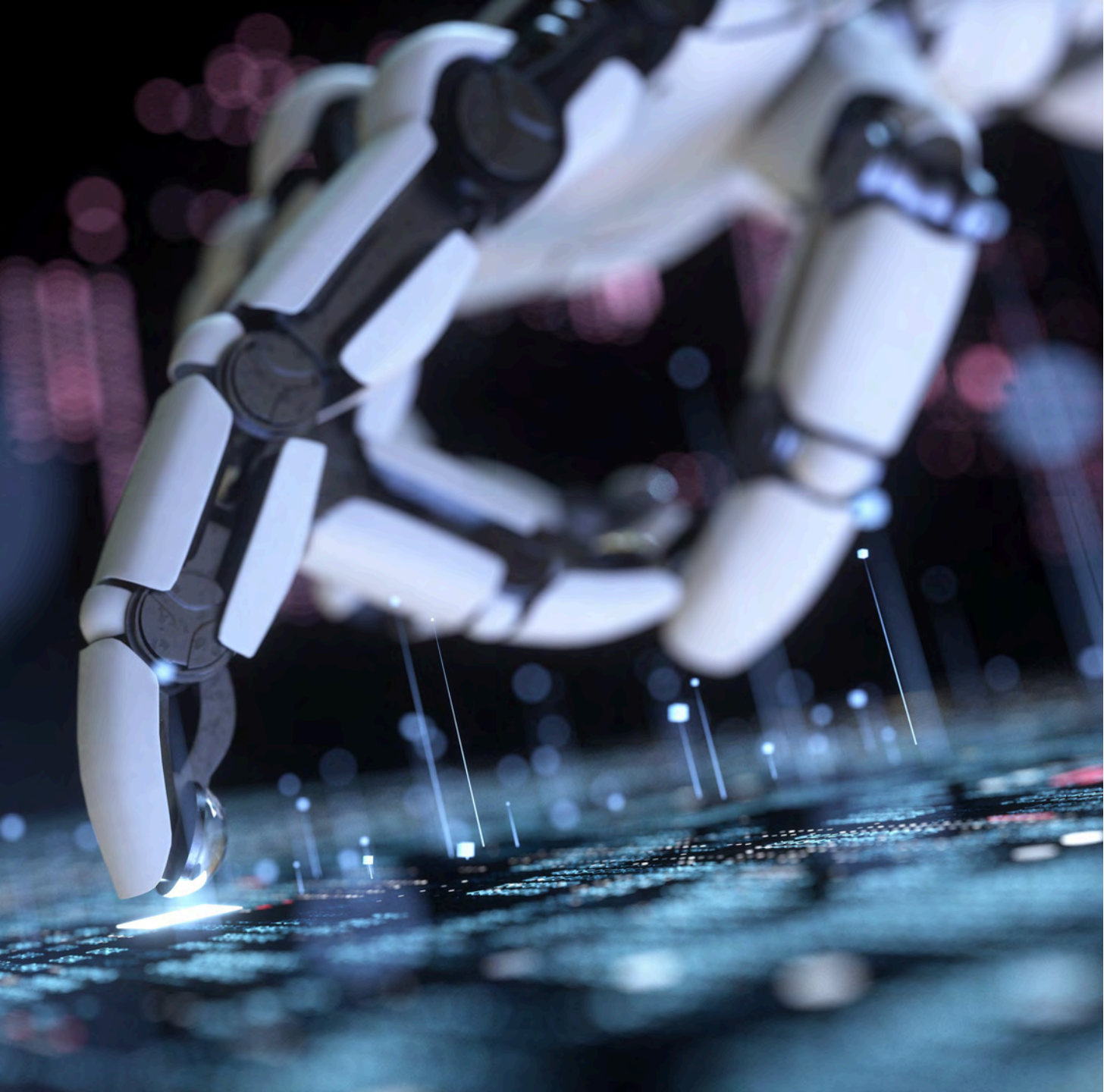
Pay for Time

- Some services charge by time used
- Stop using the service to stop the charges
- i.e. Virtual Machine Instances



Pay for GB

- Usually you pay for any data used
- Fairly cheap - $0.02 per GB per month
- Also pay for network traffic to/from other regions, or to the Internet



Pay for Operations

- In addition to paying for space, and bandwidth, you can also be charged per operation
- Operations are read, write, list, delete
- Pay per message, pay per query to a database, etc.
- Usually very cheap per operation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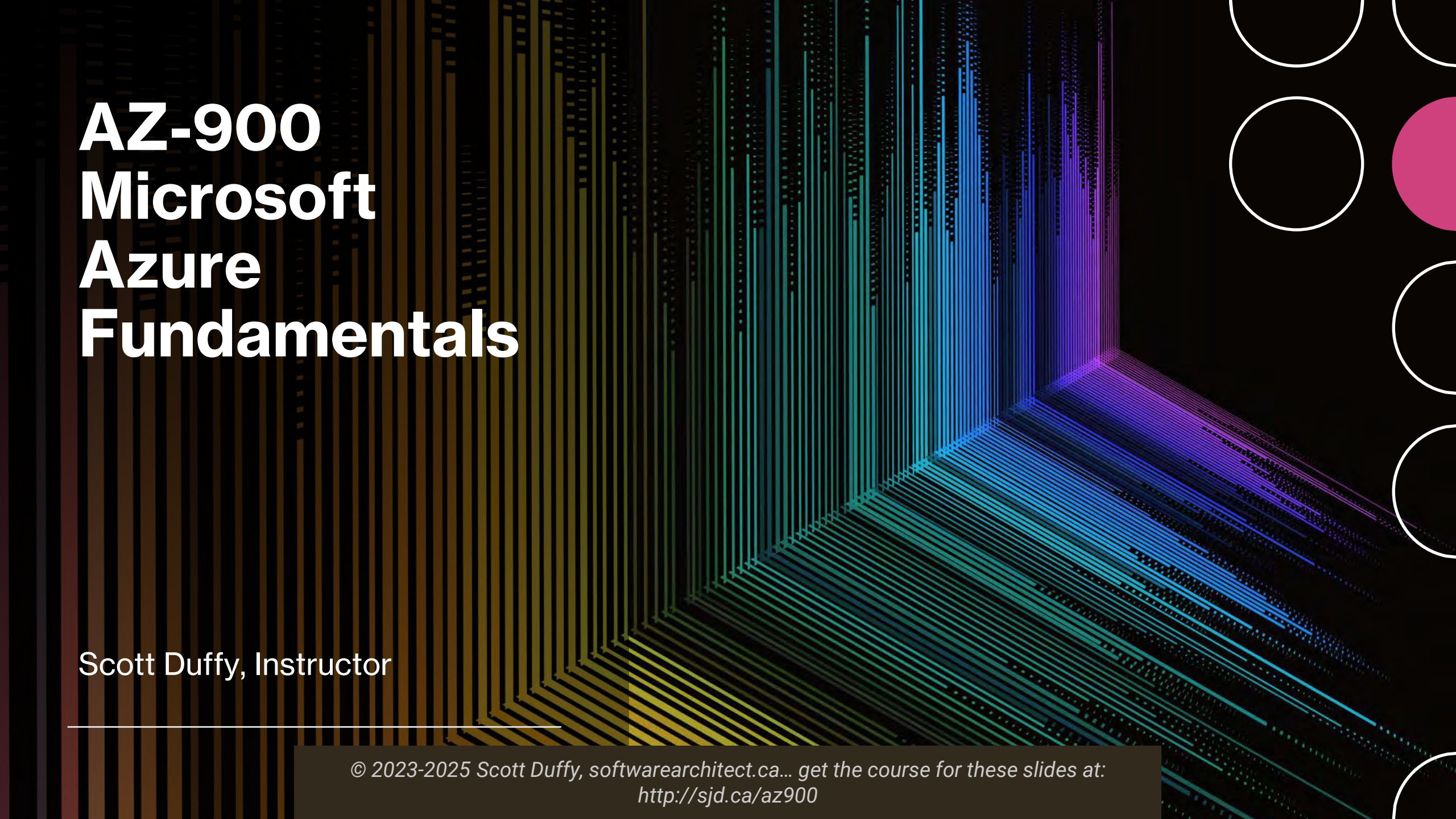

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Capital Expenditure (CapEx)

vs

Operating Expenditure (OpEx)



Capital Expenses

- These are typically “big investments”
- Property, buildings and equipment
- Physical assets
- You can re-sell them later and get some of your money back
- Government allows “depreciation” of a percentage (10%-30%) as a deduction on your taxes

Operating Expenses

- Expenses incurred through normal operations
- The cost to do business
- Rent, payroll, insurance, R&D, marketing
- 100% of expenses can be deducted against revenue, reducing the tax owing in a year

Not an Accountant

- Operating expenses are sometimes preferable to capital expenses because OpEx reduces your taxes owing this year
- CapEx takes several years (decade) to get that value back from taxes owing

Not an Accountant

- CapEx is a big investment up front and the hope that you will earn back more than the investment in revenues or profits
- OpEx requires very little investment up front and can scale with revenue


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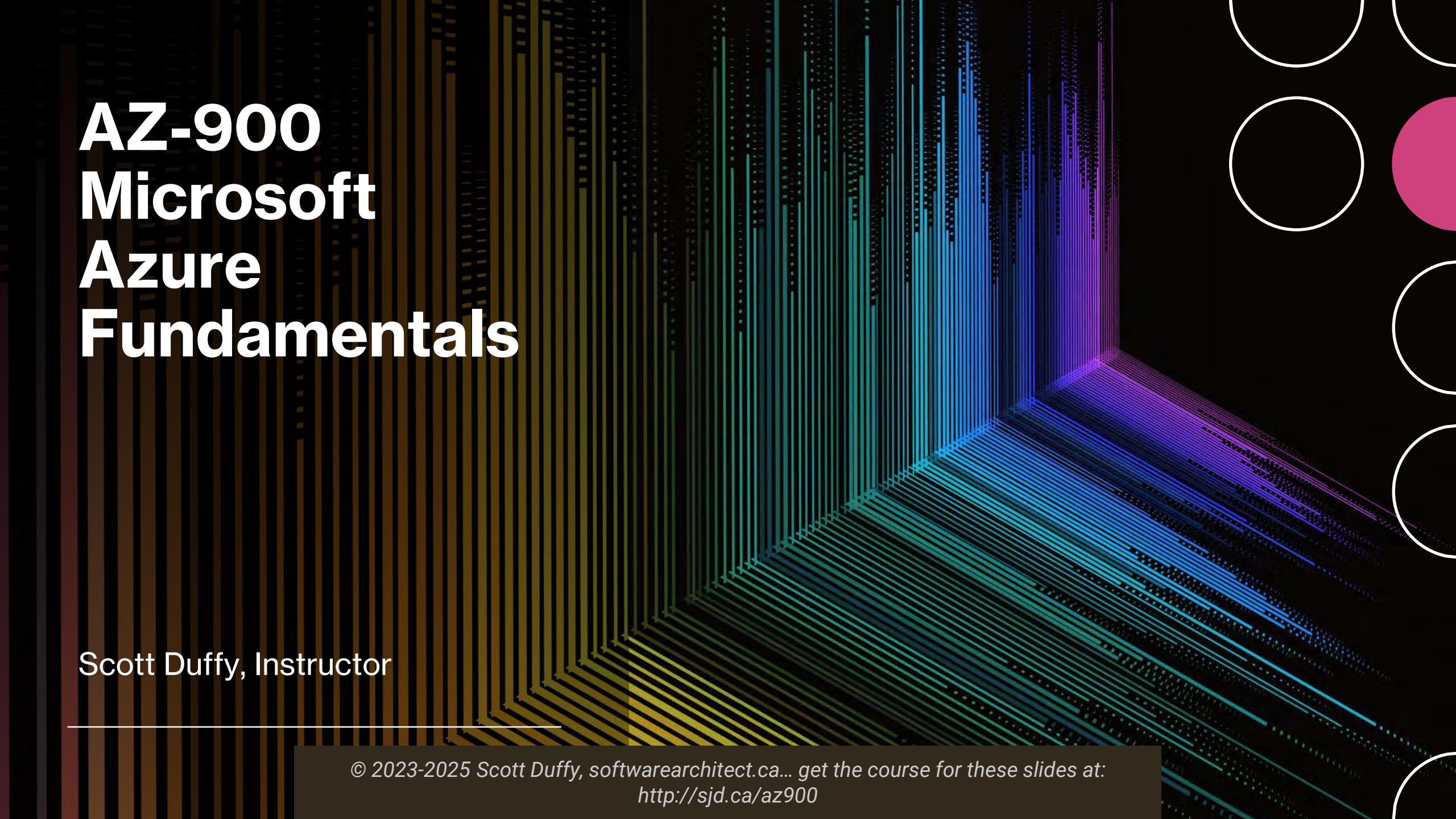

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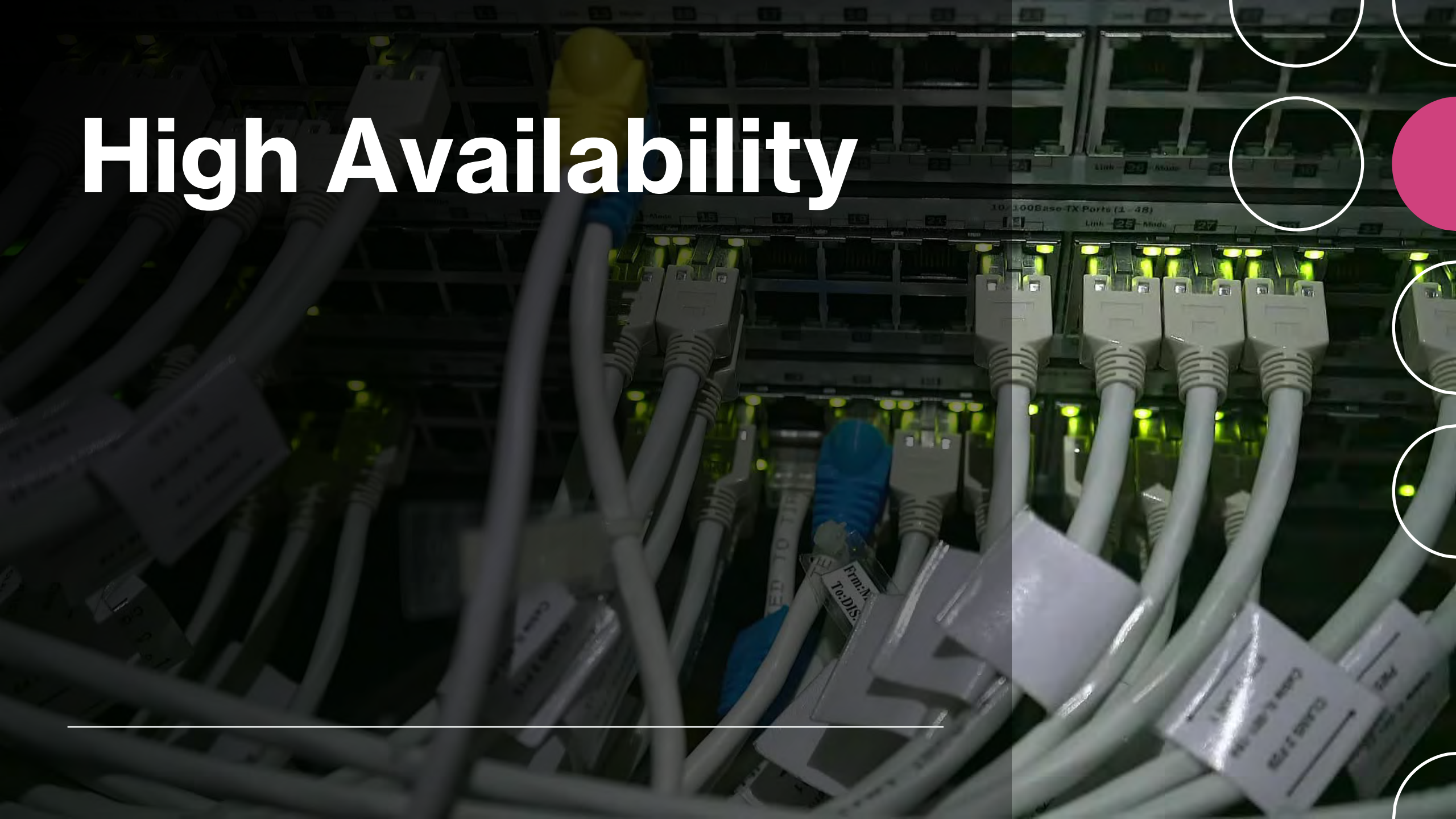
High Availability



High Availability (HA)

- Ability of a system to remain operational to users during planned or unplanned outages

Planned Outages

- Operating System security patches
- Application updates
- Hardware replacement
- Migrating to a new hosting provider

Unplanned Outages

- Hardware failure
- Network disruptions
- Power outages
- Natural disasters
- Cyber attacks
- Software bugs
- Poor scaling / architecture design

Methods to Mitigate Planned Outages

- Gradual deployment strategy
  - 1-10-100-etc
- Testing and monitoring of deployment
- Easy rollback plan
- Small deployments
- Frequent deployments
- Automation

Methods to Mitigate Unplanned Outages

- Every single core component has redundancy
- Use Azure’s built-in features for availability
  - Availability Sets
  - Availability Zones
  - Cross-Region Load Balancing / Front Door
- Constant health monitoring / probes
- Automation

Methods to Mitigate Unplanned Outages

- Strong security practices
- Be geographically distributed
- Have a disaster recovery plan
- Test that disaster recovery plan / fire drills!
- Load testing

High-Availability Is...

- A conscious effort to avoid the obvious sources of downtime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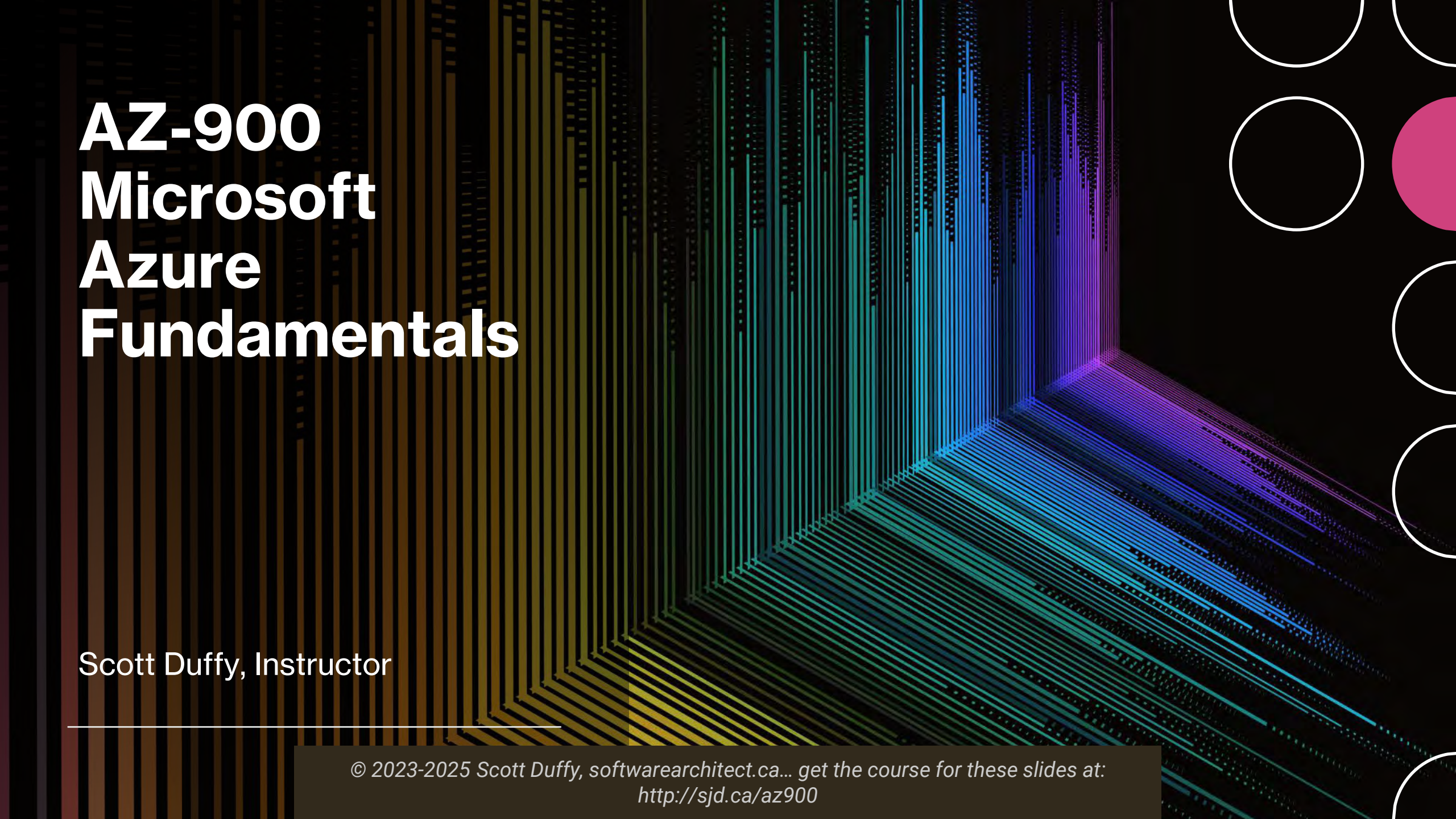

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Scalability

Scalability

- The ability of a system to accommodate increasing demand by adding or removing resources as needed.

Why Is It Needed?

- It allows a system to adapt to changing usage patterns and handle increased traffic without requiring changes to the application code or system design.

Does Traffic Fluctuate?

- Some businesses have traffic that fluctuates based on time of day or day of the year
- E-commerce websites have Black Friday
- School registrations are busy in September
- Tax systems are busy in April

The $1M Question...

- Can you expand the capacity of a system very easily, by adding more servers?
- Or will it be a massive undertaking to do that?

Vertical Scaling

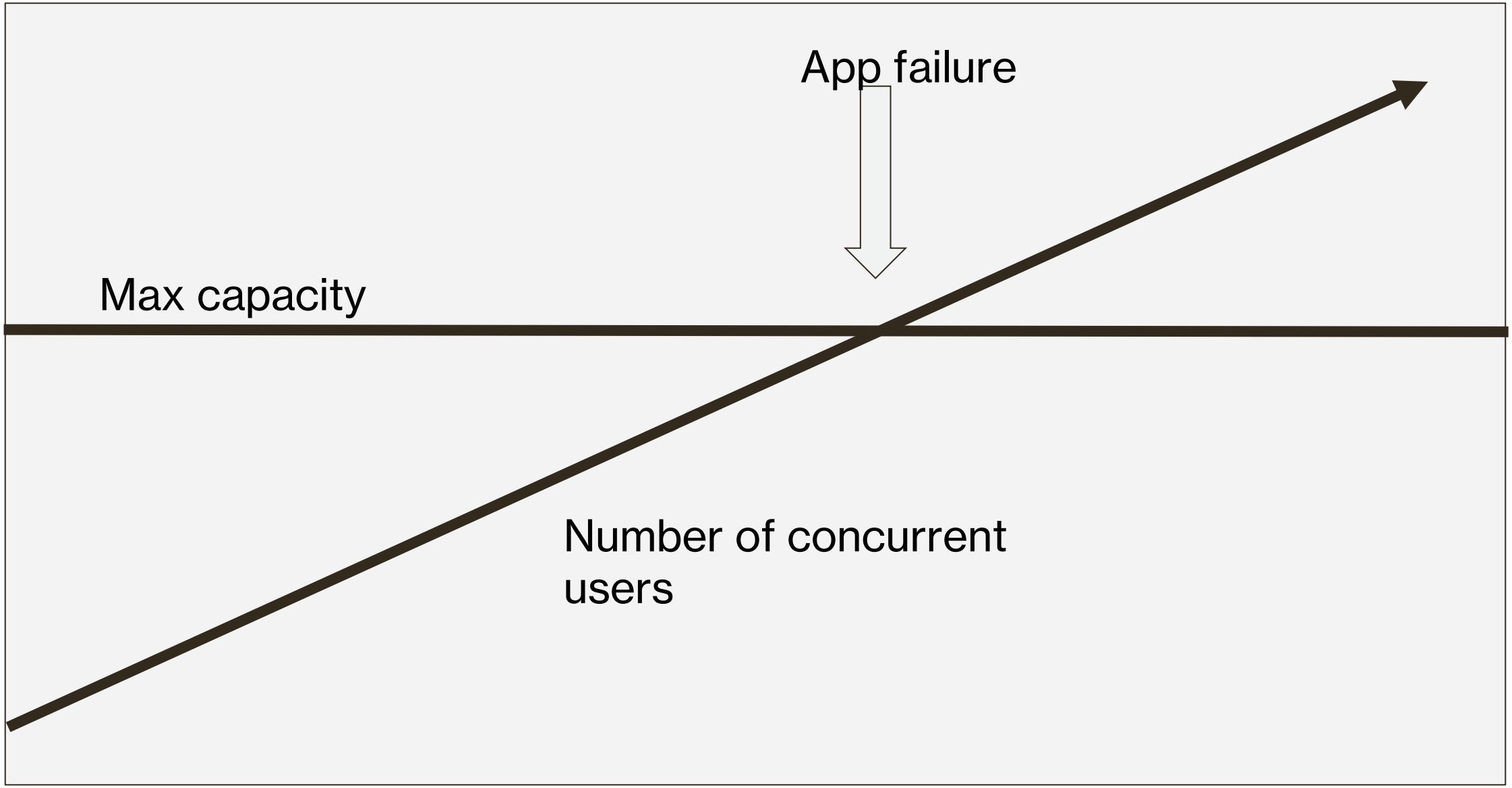
- Also called “scaling up” or “scaling down”
- Adding more resources to a single server
- Increase the amount of memory, the number of CPUs
- There is an upper limit to this
- Azure – 96 vCPUs, 384 GB memory
- (Does not improve availability)

Horizontal Scaling

- Also called “scaling out” or “scaling in”
- Adding more servers to a system
- No limits to scaling
- Additional complexities for load balancing
- (Can improve availability)

Impact on System Cost

- Adding more resources to a system adds to cost
- Reducing resources can reduce cost
- Having a scalable system allows for a system to be perfectly sized
- This optimizes the cost by reducing wasted computing resources


App failure
Max capacity
Number of concurrent users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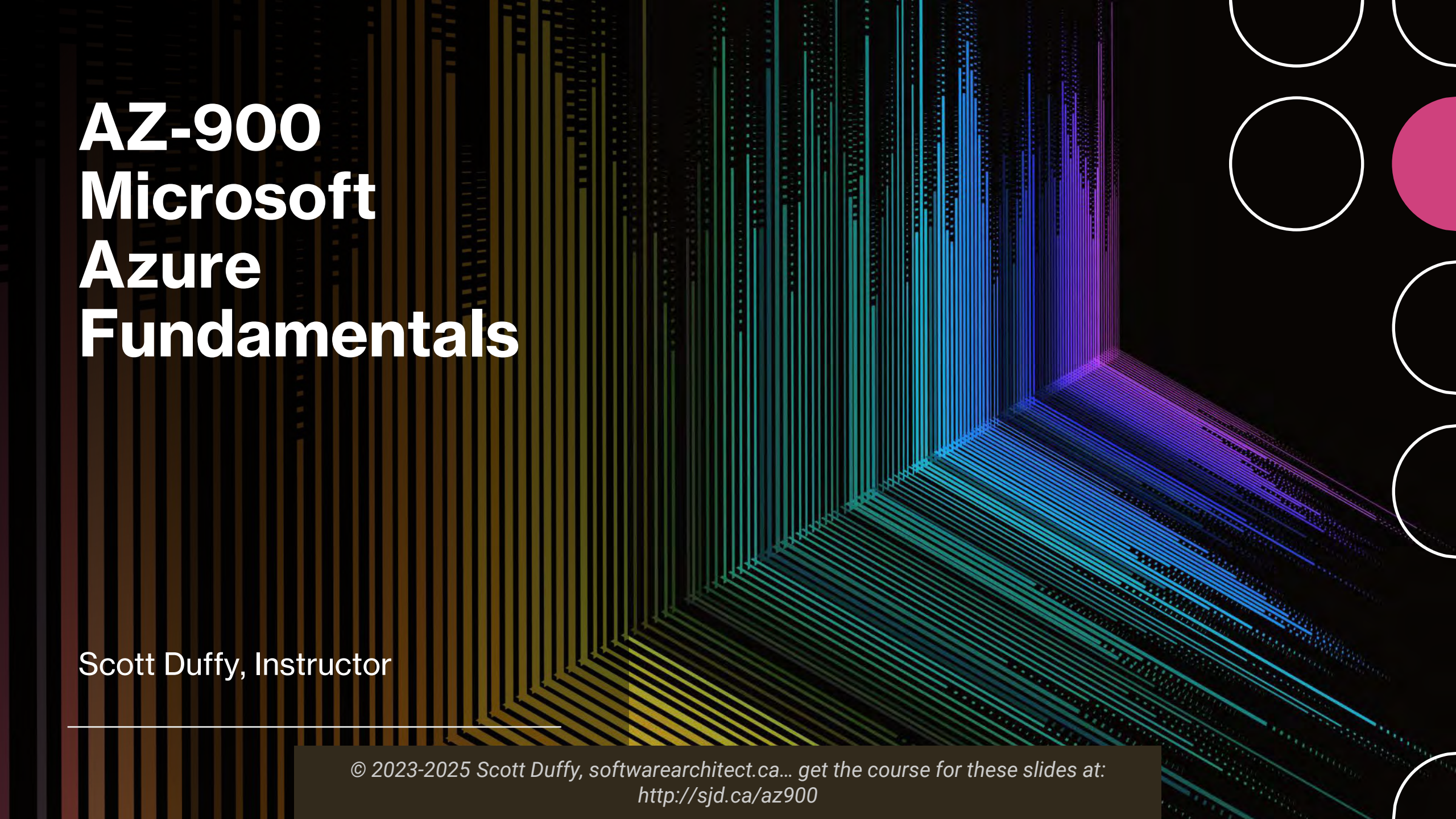

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Elasticity



Elasticity

- The ability of a system to quickly and easily scale up or down the amount of resources that a system uses in response to changing demand

Quickly and Easily

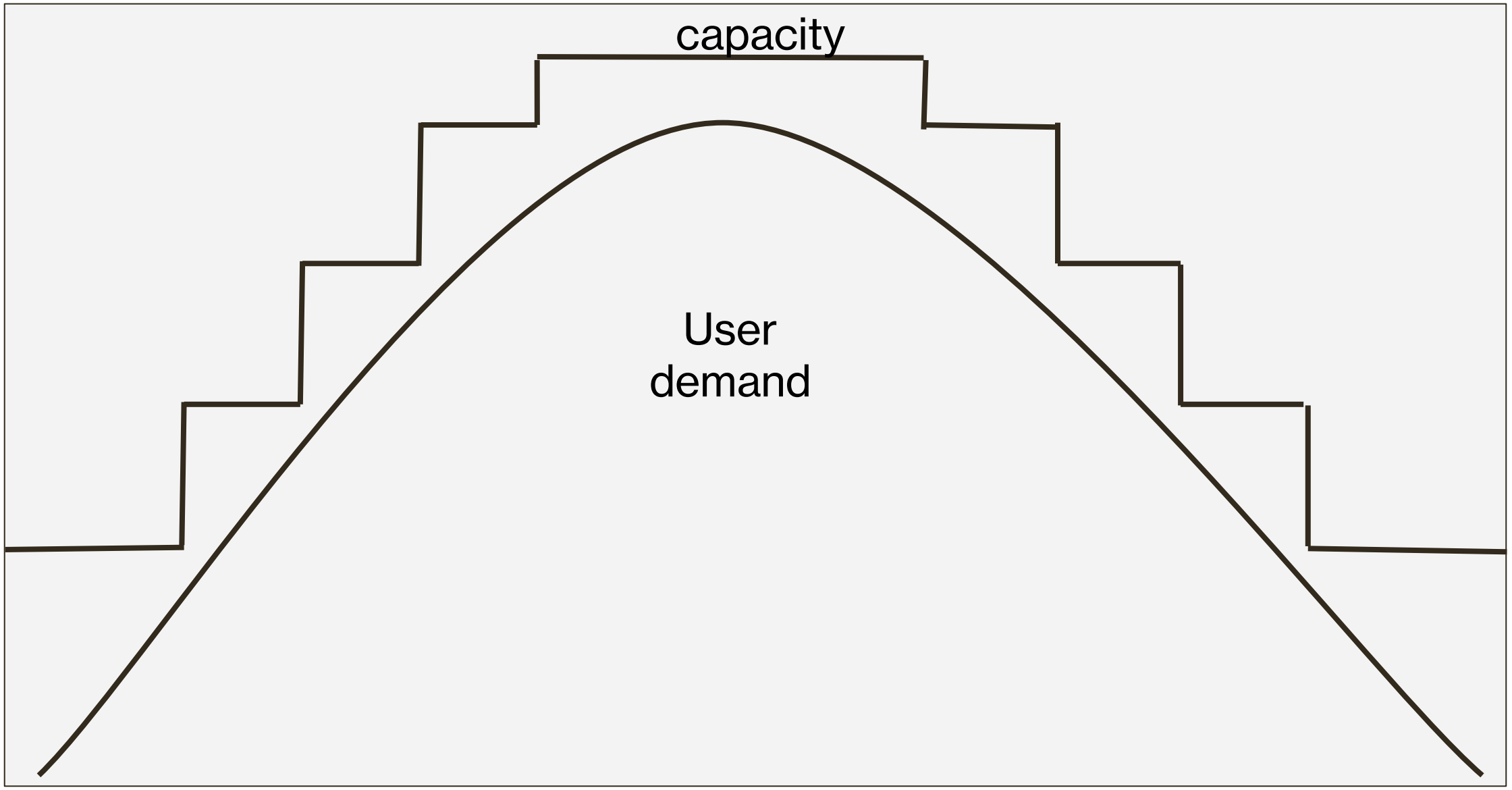
- Has to involve some sort of automation
- Often called “autoscaling” in cloud computing
- The system monitors some metric (such as CPU utilization) to determine how busy a system is
- Adds resources when it exceeds a limit for being busy
- Remove resources when it falls below a limit for being not busy

Why Is It Needed?

- More efficient and cost-effective use of resources
- Minimizes computing “waste” – resources paid for and not used
- Self-hosted systems tend to have a large percentage of “over-provisioned” resources for anticipated future growth

Save Here, Spend There

- Also have the potential to have a maximum capacity higher than you could afford if you had a static provisioning of resources


capacity
User
demand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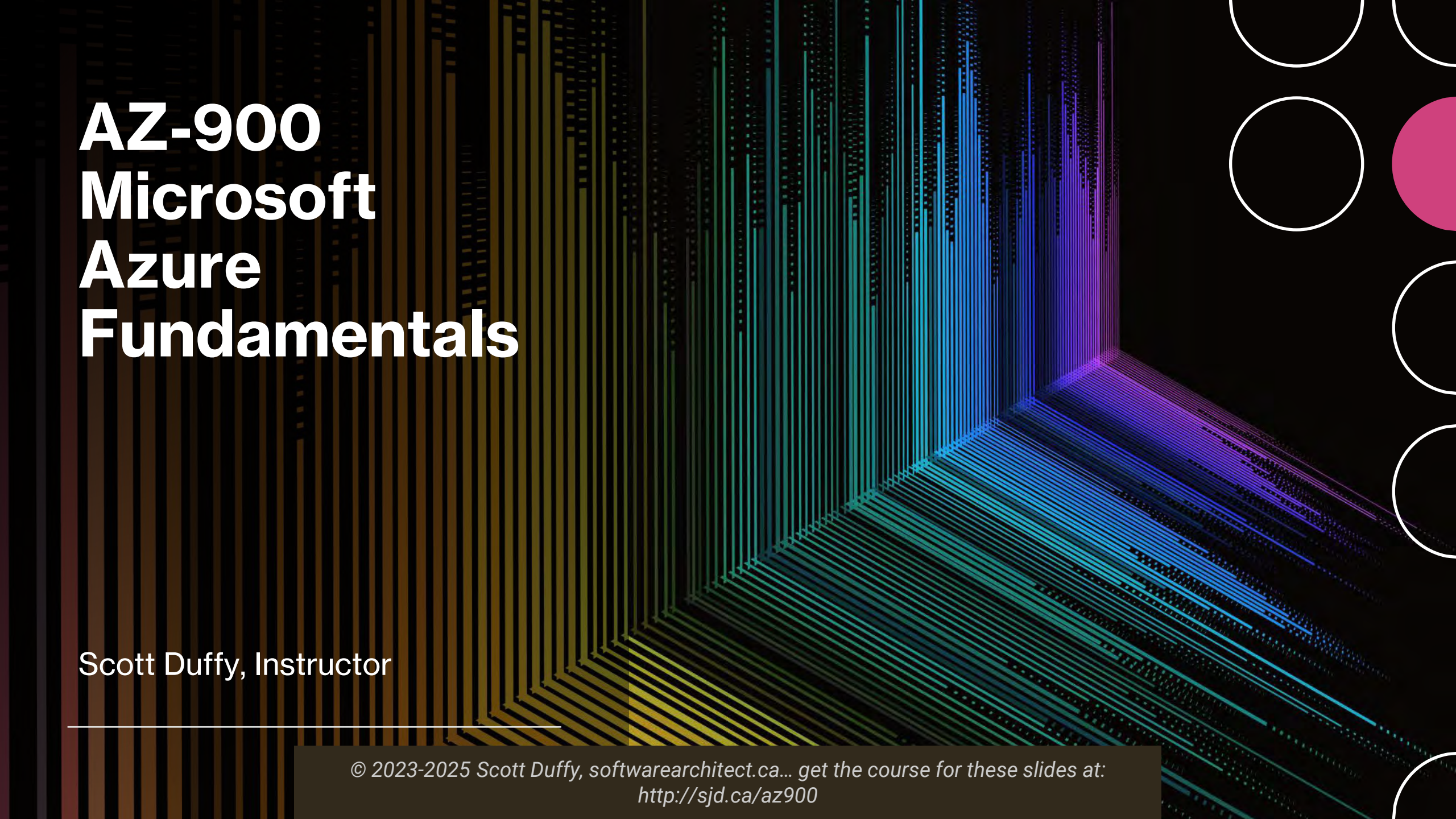

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Reliability



All Three Relating to High Quality Service

- Availability
- Reliability
- Predictability

Reminder: Availability

- The ability of a system to be accessible and usable by users when they need it

Reliability

- The ability of a system to recover from failures

- Azure has several built-in services that you can use to keep an application running after a failure has occurred

Reliability

- There are many different failures that can occur even in a well-designed system
  - Hardware failure
  - Network interruptions
  - Power failures
  - Large-scale regional outage

Why Is It Needed?

- You have to trust that your cloud provider is doing everything it can to make its platform reliable
- This includes transparency during service issues

How Is It Achieved?

- Auto-scaling
- Avoid single points of failure
- Multi-region deployments
- Data backup and replication
- Health probes and self-healing


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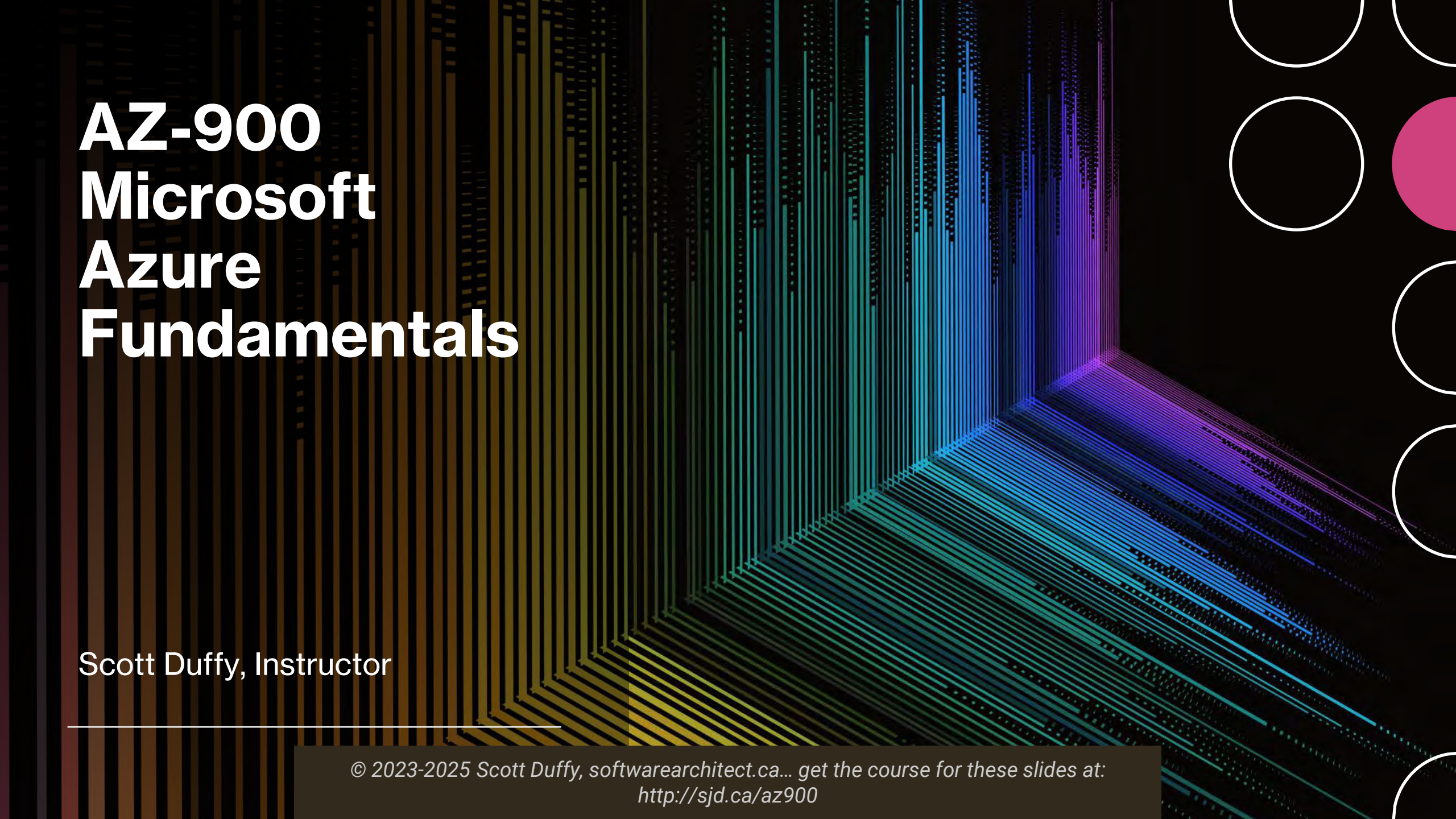

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Predictability



Predictability

- The ability to forecast and control the performance and behavior of a system
- Includes the ability to predict future costs

Why Is It Needed?

- Predictability gives you the confidence that the system will continue to perform at the expected level in the future
- And of course that you won’t get a crazy bill unexpectedly

How Is It Achieved?

- Autoscaling
- Load balancing
- Different instance types, sizes, pricing tiers
- Cost management tools
- API
- Pricing calculators


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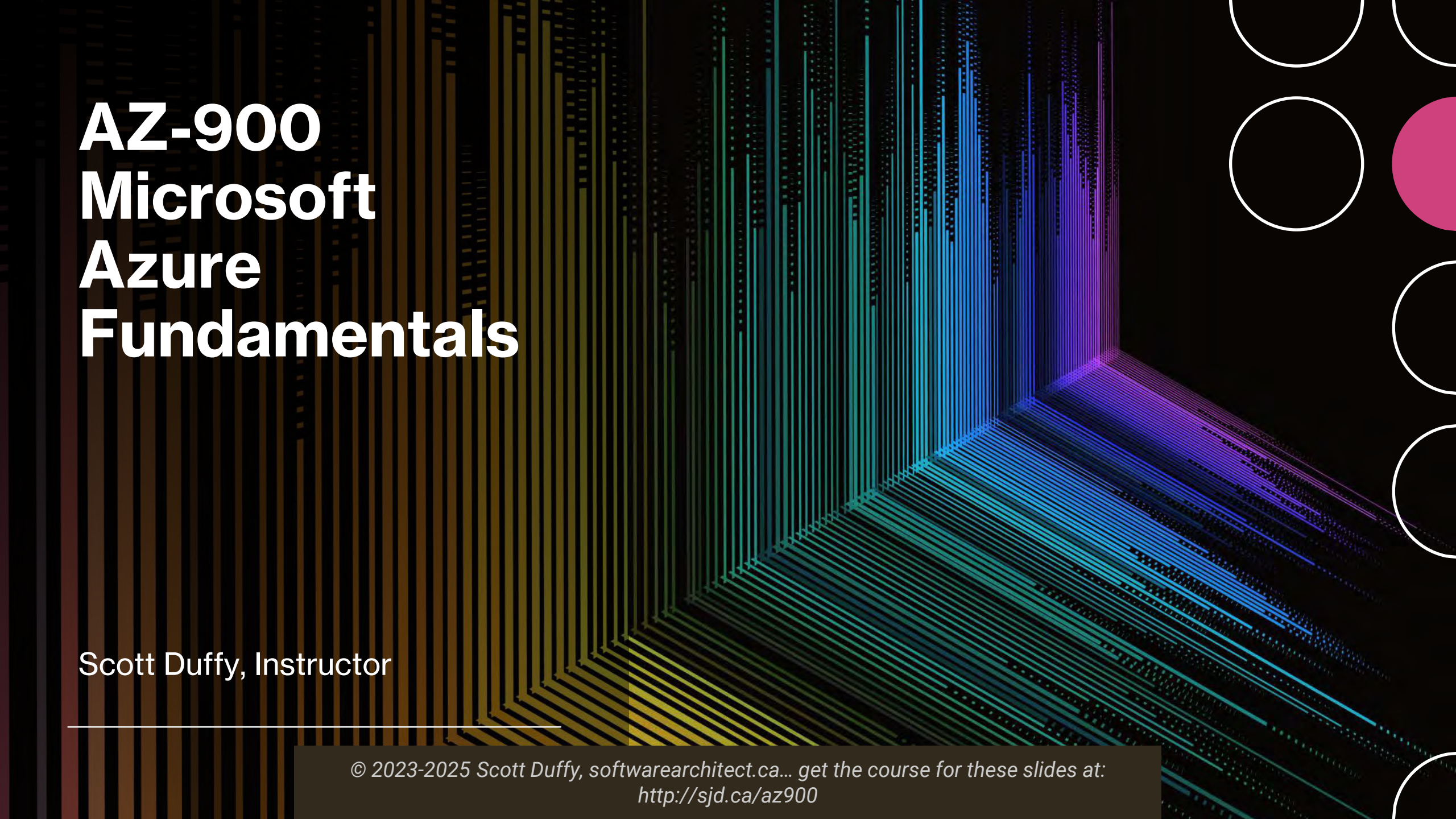

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Security



Security is a full-time job

Security

- Cloud providers are obviously massive targets for hackers, and so they rightly spend a lot of time, money and effort on platform security
- Cloud providers go through security audits and compliance certifications
- And provide customers (you) the tools they need to enable and monitor security with their own applications/data

Why Is It Needed?

- Security is a fundamental challenge in IT
- You want confidence that your cloud provider cannot easily be defeated by hackers and those with malicious intent

How Is It Achieved?

- Industry standard compliance certifications
- Microsoft Security Response Center (MSRC)
- Always-on DDoS
- Azure Policy
- Role based access control (RBAC)
- Entra ID (formerly Azure Active Directory)
- Always up-to-date platform services
- Update management
- Encryption by default
- Dozens of security services like firewall


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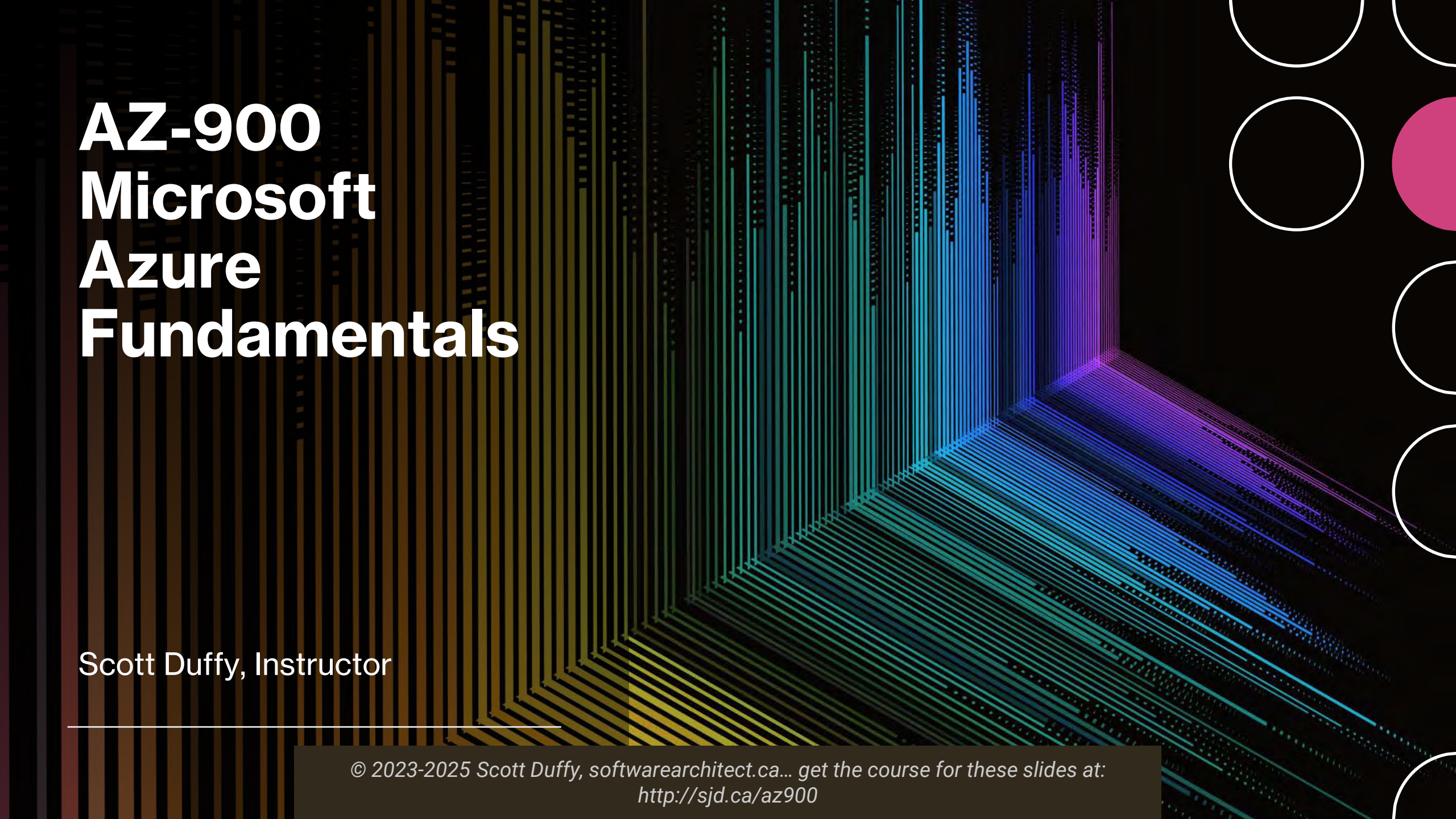

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Governance



Governance

- How your organization does business
- The process of defining, implementing, and monitoring a framework of policies that guides an organization's cloud operations

Why Is It Needed?

- Your company wants to ensure it’s policies are followed in the cloud
- Includes basic auditing and reporting, as well as enforcement
- You want to be compliant with industry standards such as HIPAA or PCC or GDPR

How Is It Achieved?

- Azure Policy
- Management groups
- Custom roles
- Soft delete
- Guides and best practices such as Cloud Adoption Framework


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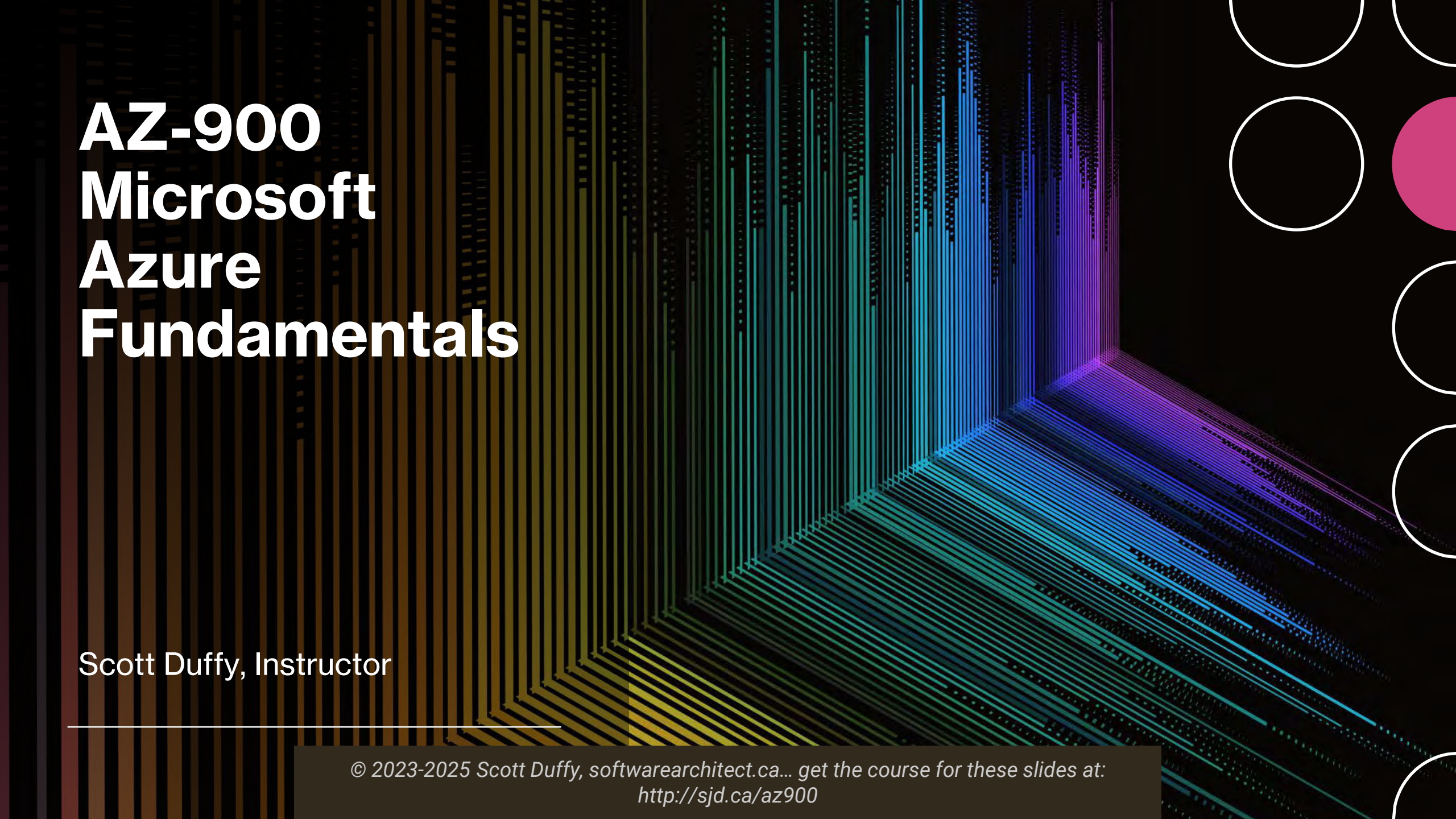

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Manageability



Manageability

- Management of the cloud
- Management in the cloud

Management of the Cloud

- Templates
- Automation
- Scaling
- Monitoring and alerts
- Self-healing

Management in the Cloud

- Web portal
- Command line interface and scripts
- APIs
- PowerShell

Why Is It Needed?

- How easy it is to work with your applications in the cloud impacts cost, performance, security and other priorities
- Different cloud vendors are going to be easier or harder to work with

How Is It Achieved?

- Azure Portal, CLI, PowerShell, Cloud Shell, REST APIs, and other programmatic methods
- Consolidated monitoring and alerting system
- Ability to use ARM templates, Bicep, Terraform, etc
- Autoscaling of most types of compute resources


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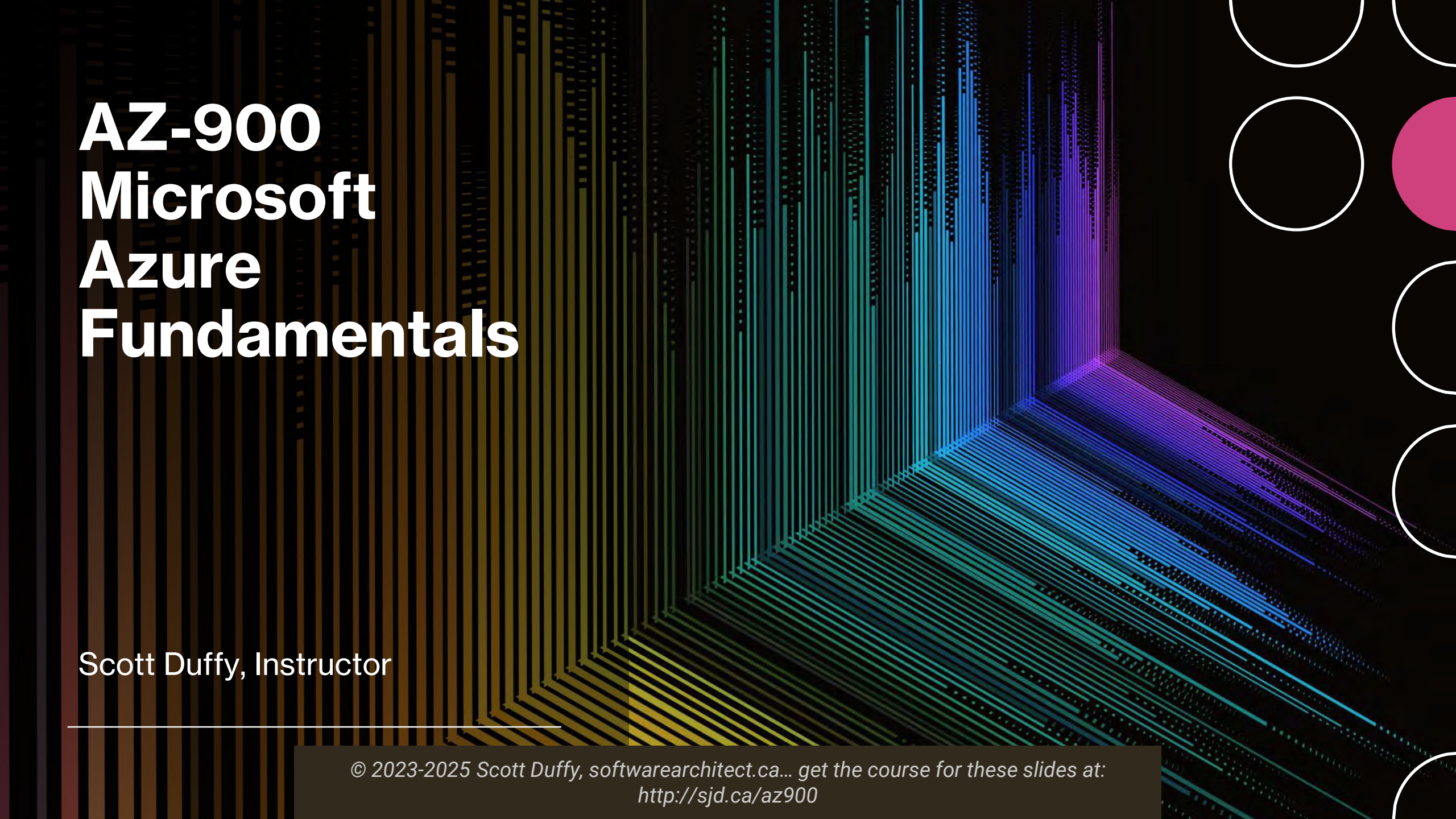

AZ-900 Microsoft Azure Fundamentals

Scott Duffy, Instructor

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Describe cloud concepts (25–30%)

Describe cloud computing

- Define cloud computing
- Describe the shared responsibility model
- Define cloud models, including public, private, and hybrid
- Identify appropriate use cases for each cloud model
- Describe the consumption-based model
- Compare cloud pricing models
- Describe serverless

Describe the benefits of using cloud services

- Describe the benefits of high availability and scalability in the cloud
- Describe the benefits of reliability and predictability in the cloud
- Describe the benefits of security and governance in the cloud
- Describe the benefits of manageability in the cloud

Describe cloud service types

- Describe infrastructure as a service (IaaS)
- Describe platform as a service (PaaS)
- Describe software as a service (SaaS)
- Identify appropriate use cases for each cloud service type (IaaS, PaaS, and SaaS)

Cloud Service Types



Cloud Service Types

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)

“As a Service”

- You can rent it for a short time, if you wish
- No commitment, if you wish
- Pay for what you use (time, GB, or other)
- Cloud provider takes care of buying, developing, and maintaining it

Infrastructure as a Service (IaaS)

- These are the essential services of technology
  - Computing
  - Networking
- Generally have “real world” equivalents in your own data center
- Cloud replacements of real world things

IaaS Computing

- One example is Azure Virtual Machines
- Pay by the second
- Many choices in CPU speeds, RAM, optimizations

IaaS

- Azure is one example of this
- 5 PB of capacity
- Can handle blobs, files, queues, and tables
- Can also be configured as a data lake

IaaS Networking

- Virtual Networking is an example of this
- Virtual Networks don’t cost anything
- There are ingress and egress bandwidth costs

Platform as a Service (PaaS)

- Cloud service providers have an opportunity to provide more than just the “basic” infrastructure
- PaaS includes a service layer on top of IaaS – computing, and networking
- Middleware, development tools, database server, and more

PaaS Computing

- One example is Azure App Services
- Simply upload your code and configuration to Azure, and it runs your code without needing to worry about the VM underneath
- Includes scaling features, CI/CD, containers, staging and development environments, etc

PaaS

- Managed is an example of this
- Azure SQL Database is another example
- Freed from worrying about the server VM itself or the hard disk itself

PaaS Networking

- Azure Front Door is an example of this
- Or Load Balancer
- Or Firewall
- These are software applications that perform networking tasks

Software as a Service (SaaS)

- Cloud apps
- Tools such as Office 365, OneDrive, Skype
- The app is ready to be used and you simply need to set it up and use it


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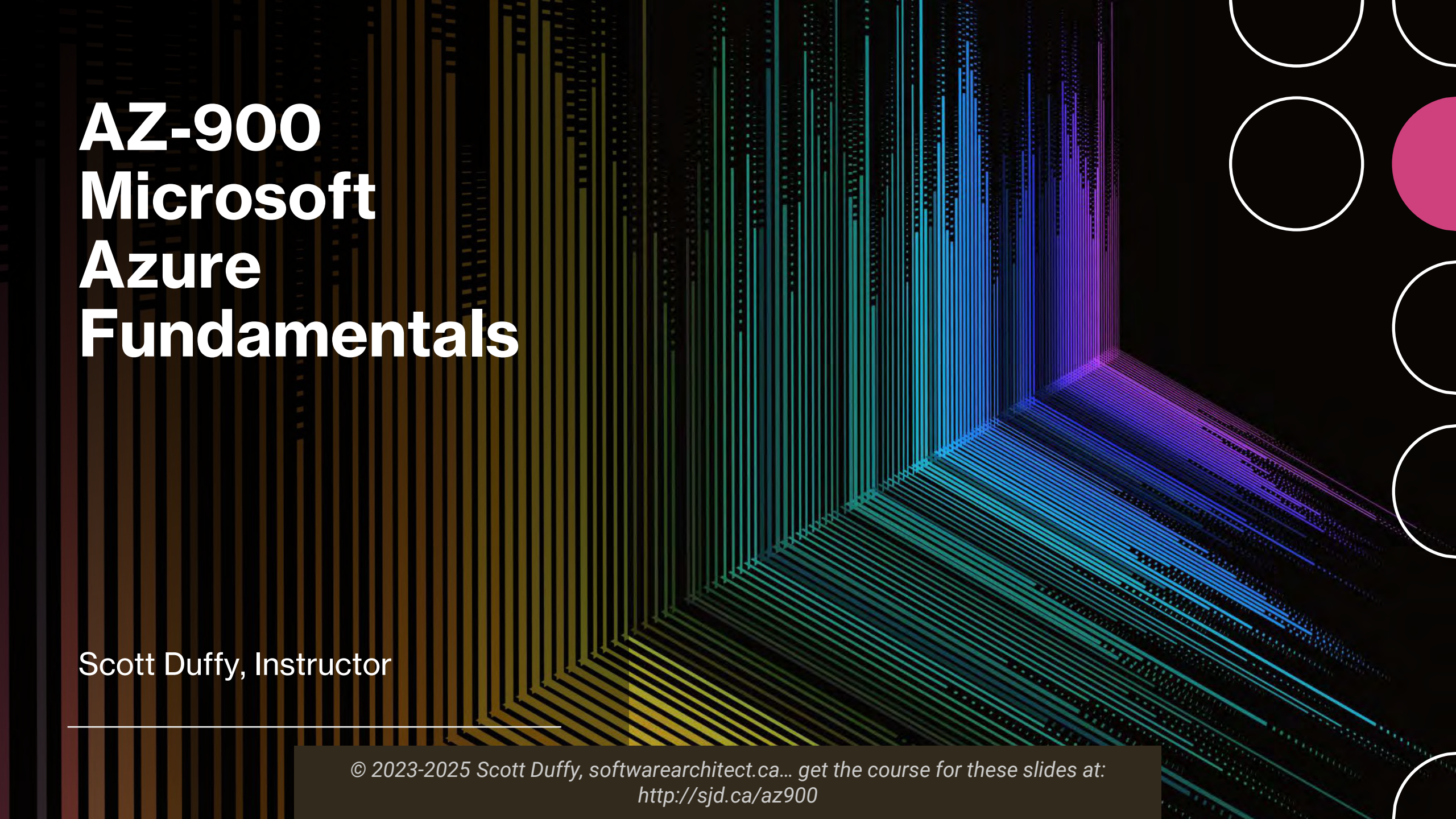

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What Does 'Serverless' Mean?

- First, you don’t manage the servers.
- You only handle writing and running the code.

Serverless = Consumption-Based Pricing

- You only pay for what you use.
- No charges when your app or database is idle.
- No need to pre-purchase or reserve resources.

Example – SQL Database Options

Azure SQL Database has multiple pricing options:

1. **DTU-based**: Fixed performance levels (S1, S2, etc.)
2. **vCore-based**: You choose CPU, memory, and
3. **Serverless**: Auto-scales CPU & memory based on usage

Serverless SQL – Key Features

- Azure auto-scales between 0.5 to 80 vCores.
- You’re charged per vCore-second and used.
- It can pause when idle, cutting costs entirely.

Example – Azure Functions

Azure Functions is a classic serverless example:

- First **1 million executions per month** are free.
- After that, you pay per execution and execution time.
- Azure handles scaling automatically.

Serverless Pros and Cons

Advantages:

- No server management
- Scales automatically
- Cost-efficient for intermittent workloads

Challenges:

- Costs may vary month-to-month
- Cold starts may cause slight delays

Serverless means:

- You focus on code, not infrastructure
- You pay based on actual usage
- It’s ideal for event-driven or low-usage workloads

Serverless Services

- Functions
- Container Apps
- Kubernetes
- SQL Database
- Cosmos DB


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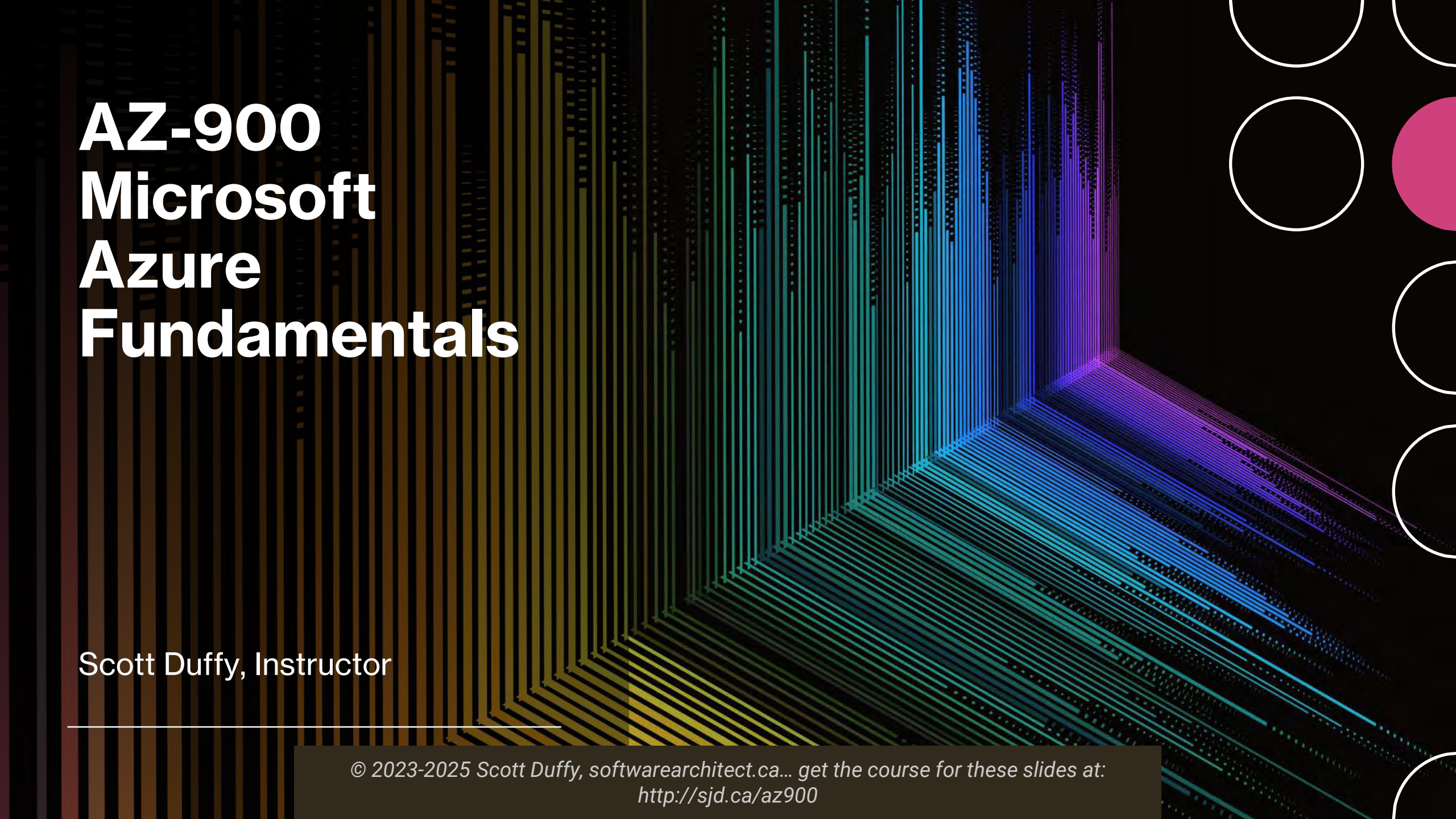

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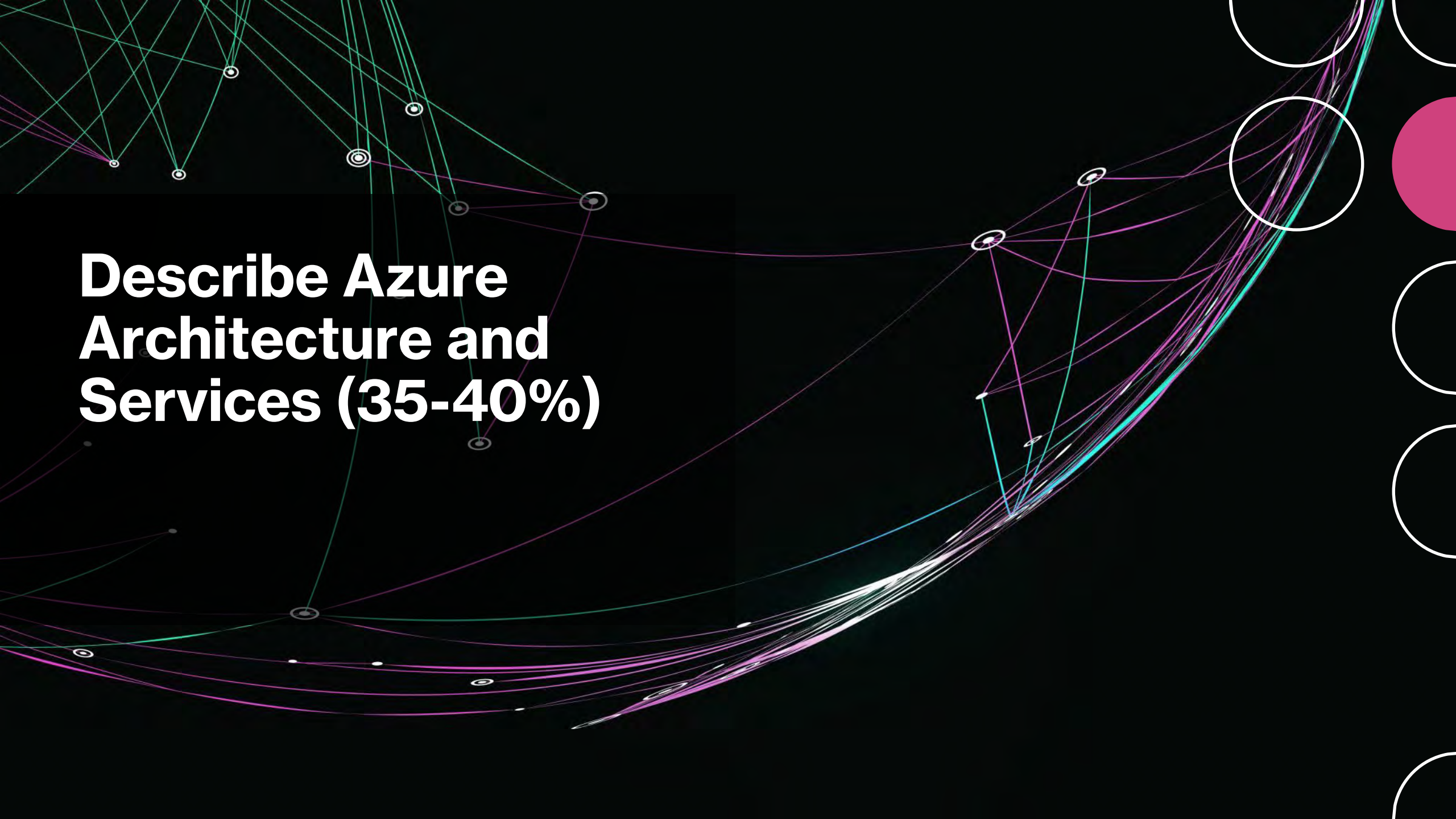
Describe Azure Architecture and Services (35-40%)



Describe Azure architecture and services (35–40%)

Describe the core architectural components of Azure

- Describe Azure regions, region pairs, and sovereign regions
- Describe availability zones
- Describe Azure datacenters
- Describe Azure resources and resource groups
- Describe subscriptions
- Describe management groups
- Describe the hierarchy of resource groups, subscriptions, and management groups

Describe Azure compute and networking services

- Compare compute types, including container instances, virtual machines (VMs), and functions
- Describe VM options, including Azure Virtual Machines, Azure Virtual Machine Scale Sets, availability sets, and Azure Virtual Desktop
- Describe resources required for virtual machines
- Describe application hosting options, including the Web Apps feature of Azure App Service, containers, and virtual machines

- Describe virtual networking, including the purpose of Azure virtual networks, Azure virtual subnets, peering, Azure DNS, Azure VPN Gateway, and ExpressRoute
- Define public and private endpoints

Describe Azure storage services

- Compare Azure Storage services
- Describe storage tiers
- Describe redundancy options
- Describe storage account options and storage types
- Identify options for moving files, including AzCopy, Azure Storage Explorer, and Azure File Sync
- Describe migration options, including Azure Migrate and Azure Data Box

Describe Azure identity, access, and security

- Describe directory services in Azure, including Microsoft Entra ID and Microsoft Entra Domain Services
- Describe authentication methods in Azure, including single sign-on (SSO), multi-factor authentication (MFA), and passwordless
- Describe external identities in Azure, including business-to-business (B2B) and business-to-customer (B2C)
- Describe Microsoft Entra Conditional Access
- Describe Azure role-based access control (RBAC)
- Describe the concept of Zero Trust
- Describe the purpose of the defense-in-depth model
- Describe the purpose of Microsoft Defender for Cloud

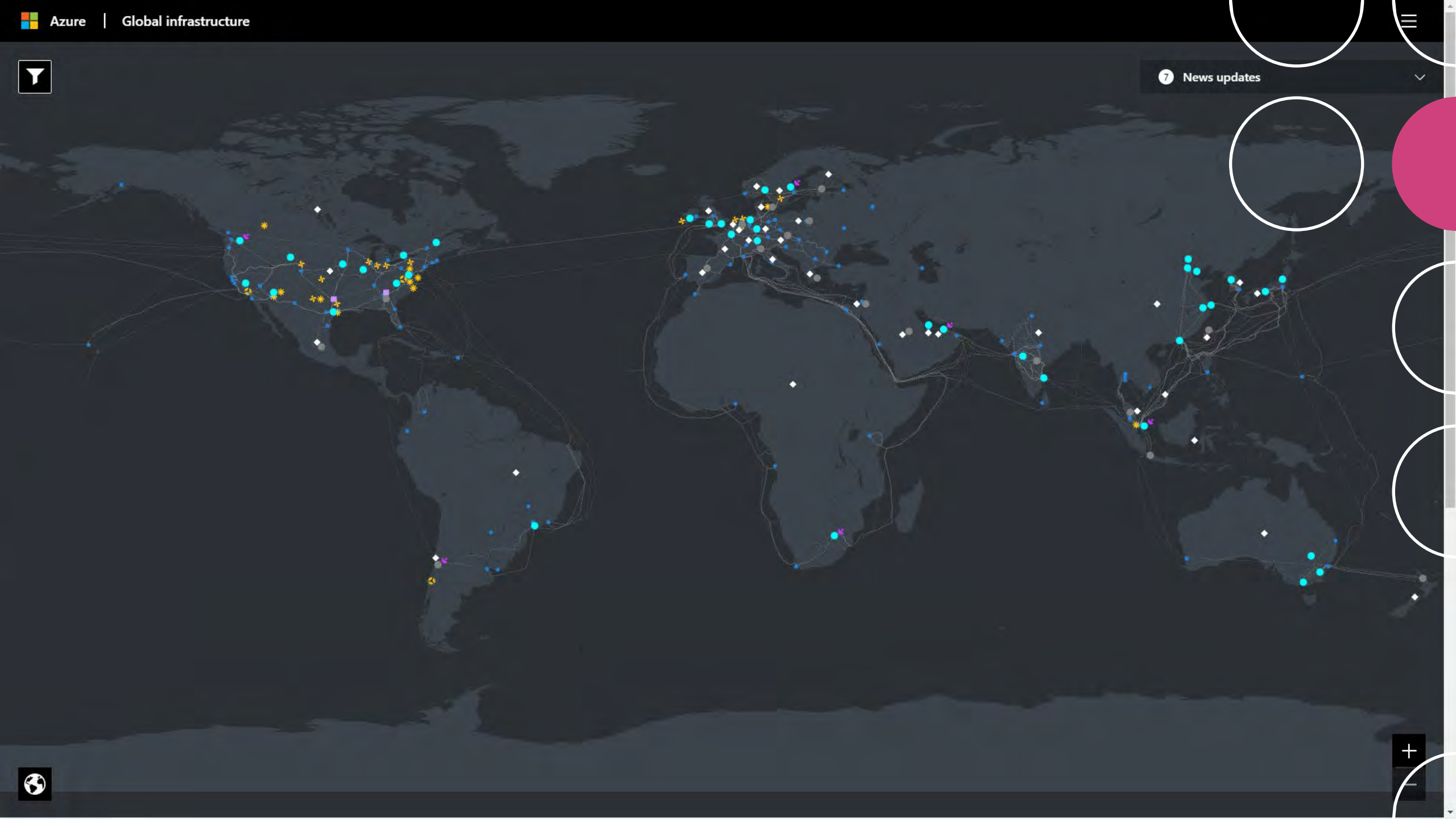
Core Azure Architecture

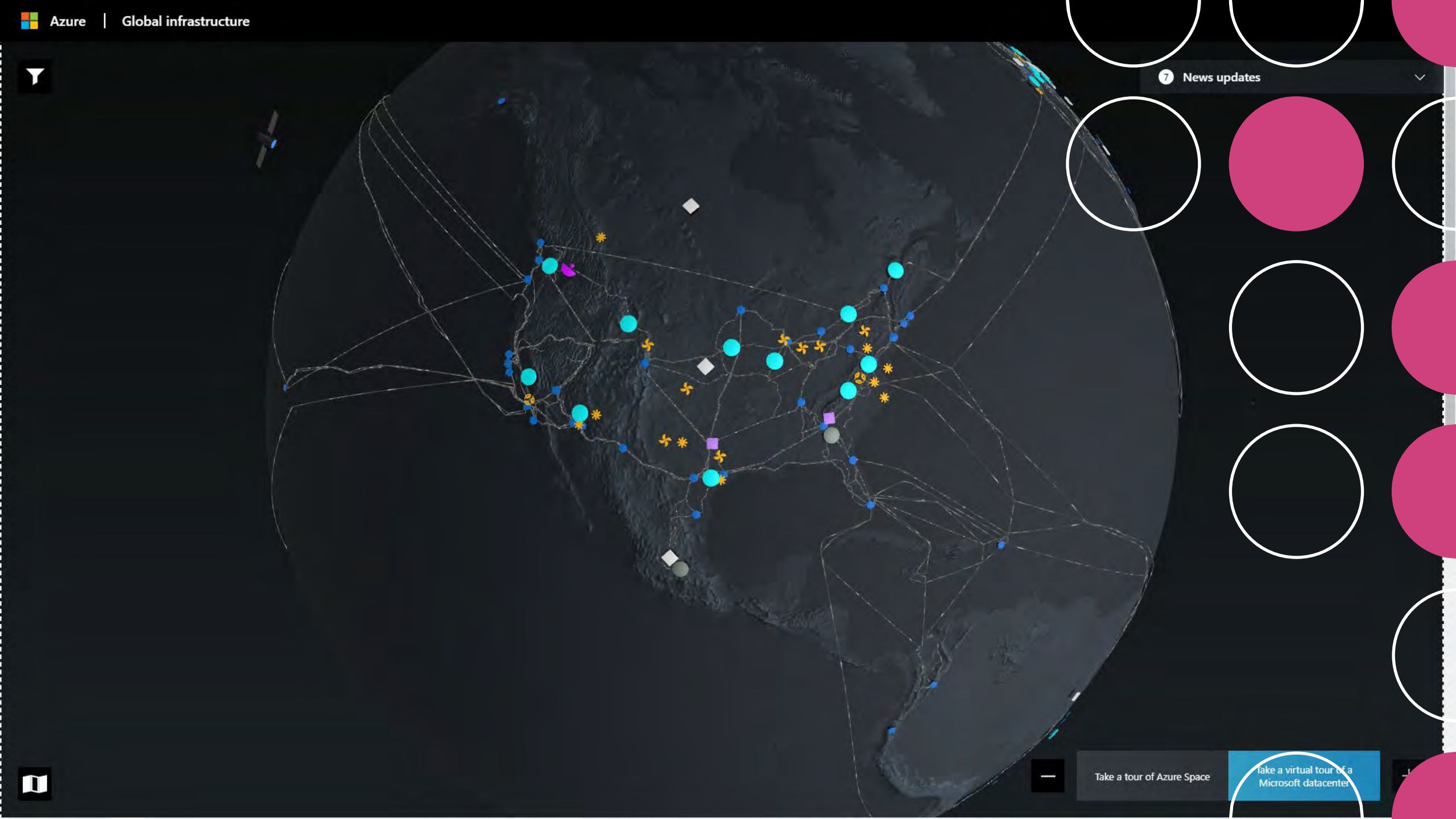


Azure Regions
Region Pairs
Sovereign Regions

Regions

- Areas of the world where Azure has a **set of datacenters** (minimum 3 in a set)
- Not necessarily “countries” but can be
- Usually each region is connected to another region to make a “region pair”
- Region pairs have highest speed connections and special treatment during Azure updates


Azure | Global infrastructure
7 News updates


Azure | Global infrastructure
7 News updates
Take a tour of Azure Space
Take a virtual tour of a Microsoft datacenter


Azure | Global infrastructure
7 News updates
Take a tour of Azure Space
Take a virtual tour of a Microsoft datacenter


Azure | Global infrastructure
7 News updates
Take a tour of Azure Space
Take a virtual tour of a Microsoft datacenter

E.g. Canada

- Canada has two regions – Canada Central and Canada East
- Data stored in these regions never leaves Canada
- Anyone can use these regions

E.g. Brazil

- Brazil only has one region – Brazil South
- Currently is the only region in South America, but Chile is coming online soon
- Paired with South Central US (one way)
- Data does leave Brazil (to the US)

E.g. Qatar

- Qatar is the first region that does not have a pair
- Does not support Geo-Redundant (GRS) option
- Uses Availability Zones for high availability

Example Pairs

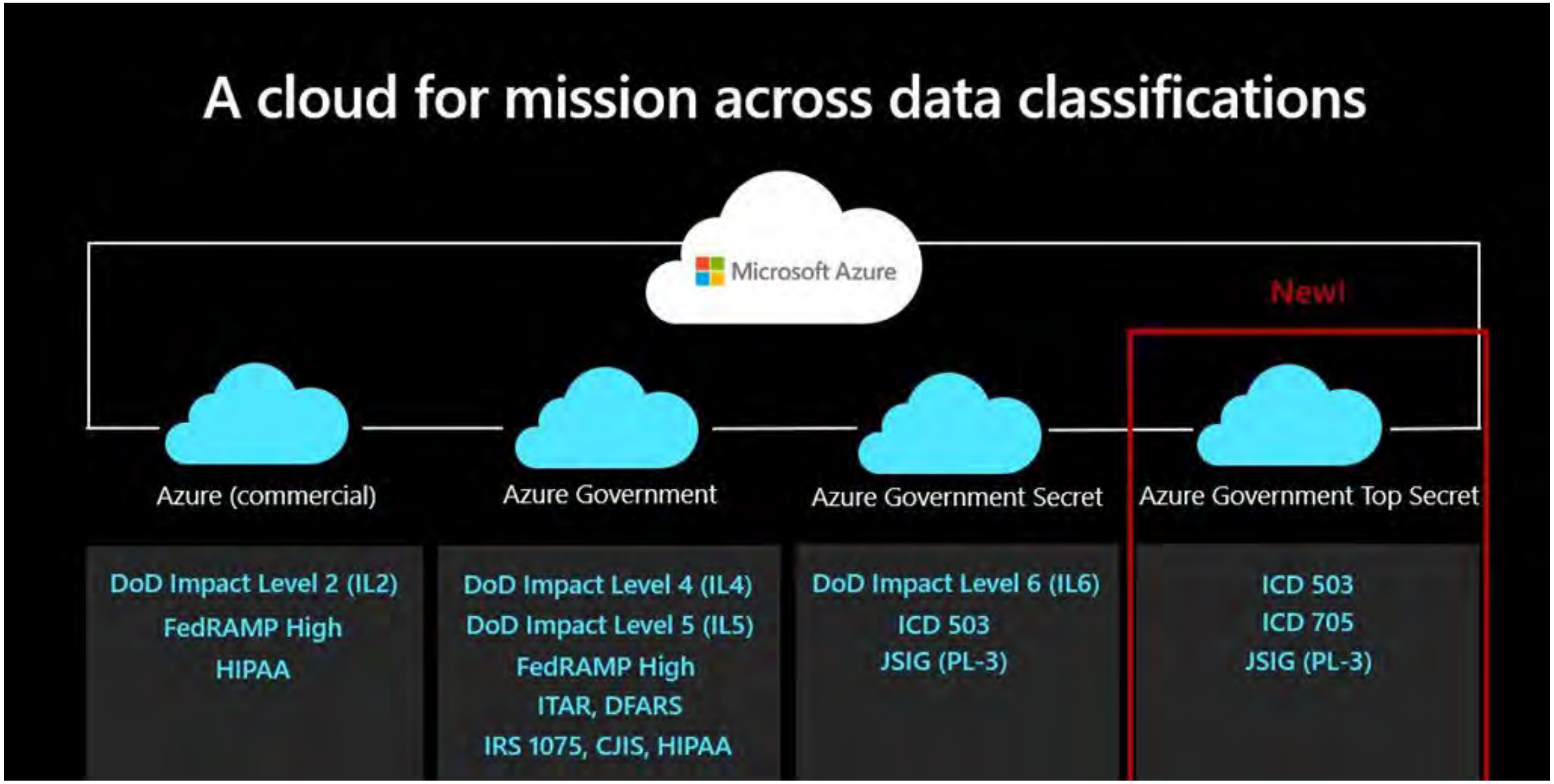
- Canada — Canada Central - Canada East
- Europe — North Europe - West Europe
- USA — East US - West US
- USA — East US 2 - Central US
- USA — North Central US - South Central US
- Brazil — Brazil South -> South Central US

60+ regions but most of them are not available to everyone

Sovereign Regions

Sovereign Azure

- These are not connected to the Azure Public Cloud
- Require approval to join / create a subscription
- Adhere to different compliance standards


A cloud for mission across data classifications
Microsoft Azure
New!
Azure (commercial)
Azure Government
Azure Government Secret
Azure Government Top Secret
DoD Impact Level 2 (IL2)
FedRAMP High
HIPAA
DoD Impact Level 4 (IL4)
DoD Impact Level 5 (IL5)
FedRAMP High
ITAR, DFARS
IRS 1075, CJIS, HIPAA
DoD Impact Level 6 (IL6)
ICD 503
JSIG (PL-3)
ICD 503
ICD 705
JSIG (PL-3)

Regions	US DoD Central	US DoD East	US Gov Arizona	US Gov Texas	US Gov Virginia
	Get started >	Get started >	Get started >	Get started >	Get started >
LOCATION	Iowa	Virginia	Arizona	Texas	Virginia
YEAR OPENED	2017	2017	2017	2017	2014
AVAILABILITY ZONES PRESENCE	Nearest region with zones available: US Gov Virginia	Nearest region with zones available: US Gov Virginia	Coming soon	Nearest region with zones available: US Gov Virginia	Available with 3
Compliance	Azure compliance offerings	Azure compliance offerings	Azure compliance offerings	Azure compliance offerings	Azure compliar
DATA RESIDENCY	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest i Sovereign offe isolated instanc Learn more
DISASTER RECOVERY	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region o Azure Site Recc Region Pairing
PRODUCTS BY REGION	See products in this region	See products in this region	See products in this region	See products in this region	See products ir
AVAILABLE TO	Reserved for exclusive use by the Department of Defense	Reserved for exclusive use by the Department of Defense	US government entities and their partners only	US government entities and their partners only	US governmen partners only

US Gov Texas	US Gov Virginia	US Sec East	US Sec West	US Sec West Central
Get started >	Get started >	Get started >	Get started >	Coming soon
Texas	Virginia	Undisclosed	Undisclosed	Undisclosed
2017	2014	2020	2020	Coming soon
Nearest region with zones available: US Gov Virginia	Available with 3 zones	Nearest region with zones available: US Gov Virginia	Nearest region with zones available: US Gov Virginia	Nearest region with zones available: US Gov Virginia
Azure compliance offerings	Azure compliance offerings	Azure compliance offerings	Azure compliance offerings	Azure compliance offerings
Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more	Stored at rest in the United States. Sovereign offering: Physically isolated instance of Microsoft Azure Learn more
Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing
See products in this region	See products in this region	Products available in this region are not disclosed	Products available in this region are not disclosed	Products available in this region are not disclosed
US government entities and their partners only	US government entities and their partners only	US government entities and their partners only	US government entities and their partners only	US government entities and their partners only

Regions	China East Get started >	China East 2 Get started >	China North Get started >	China North 2 Get started >	China North 3 Get started >
LOCATION	Shanghai	Shanghai	Beijing	Beijing	Hebei
YEAR OPENED	2014	2018	2014	2018	2022
AVAILABILITY ZONES PRESENCE	Nearest region with zones: China North 3	Nearest region with zones: China North 3	Nearest region with zones: China North 3	Nearest region with zones: China North 3	Available with
Compliance	Azure compliance offerings	Azure compliance offerings	Azure compliance offerings	Azure compliance offerings	Azure compliar
DATA RESIDENCY	A sovereign offering: independent, dedicated network within China Learn more	A sovereign offering: independent, dedicated network within China Learn more	A sovereign offering: independent, dedicated network within China Learn more	A sovereign offering: independent, dedicated network within China Learn more	A sovereign off dedicated netw Learn more
DISASTER RECOVERY	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region options: Azure Site Recovery Region Pairing	Cross-region o Azure Site Recc Region Pairing
PRODUCTS BY REGION	See products in this region	See products in this region	See products in this region	See products in this region	See products ir
AVAILABLE TO	Organizations with a business presence in China	Organizations with a business presence in China	Organizations with a business presence in China	Organizations with a business presence in China	Organizations presence in Chi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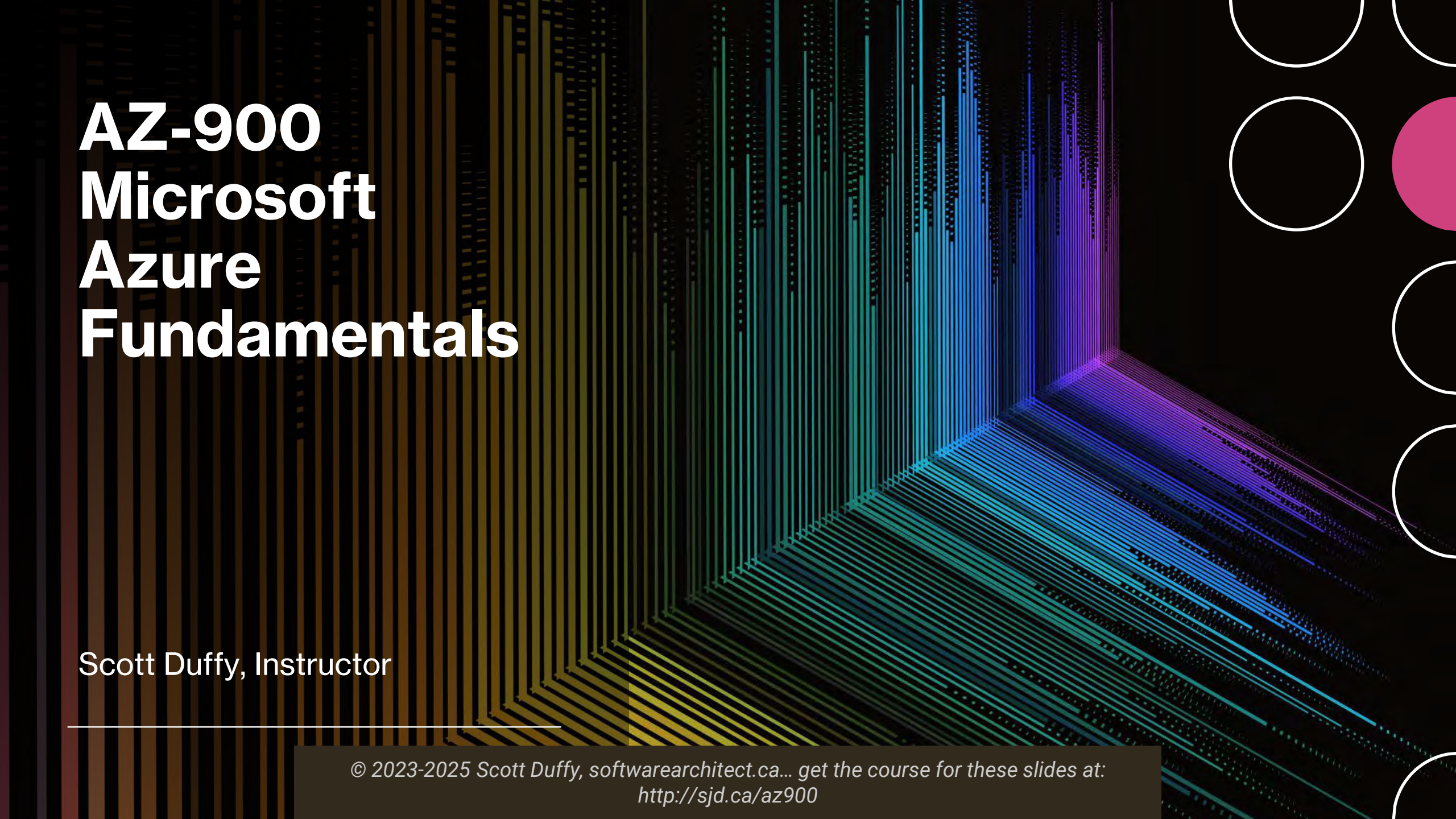

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Availability Zones

Azure availability zones are physically separate locations within each Azure region.


AVAILABILITY ZONE 1
AVAILABILITY ZONE 3
One or more data centers
Diverse fiber paths connecting Availability Zones
One or more data centers
One or more data centers
Azure Region

Independent power, cooling, and networking infrastructure



Not every region supports Availability Zones

Regions with Availability Zones

The Americas

Brazil South

Canada Central

Central US - East US - East US 2

South Central US - West US 2 - West US 3

US Gov Virginia

Mexico Central

Chile Central

Europe

France Central

Italy North

Germany West Central

North Europe - West Europe

Norway East

UK South

Sweden Central

Switzerland North

Poland Central

Spain Central

Austria Central

Regions with Availability Zones

Middle East
Qatar Central
UAE North
Israel Central

Africa
South Africa North

Asia Pacific
Australia East
New Zealand North
Central India
Japan East – Japan West
Korea Central
Southeast Asia - East Asia
China North 3
Indonesia Central
Malaysia West

Not every service supports Availability Zones

Three Types of AZ Services

- Zonal Services
- Zone-Redundant Services
- Always Available Services

Zonal Services

- You can choose a specific Availability Zone to deploy the service to
- You then should deploy a duplicate service to another zone to achieve resiliency
- E.g. Virtual Machines

Zone-Redundant Services

- Automatically deployed across zones for you
- You don’t have to configure it
- E.g. Azure SQL Database

Always Available Services

- These are global services and Microsoft takes care of the ensuring that they are always on
- Also called “Non-regional services”
- E.g. Azure Portal, Entra ID (formerly Azure Active Directory), Azure Front Door



Some services give you the choice between zonal and zone-redundant


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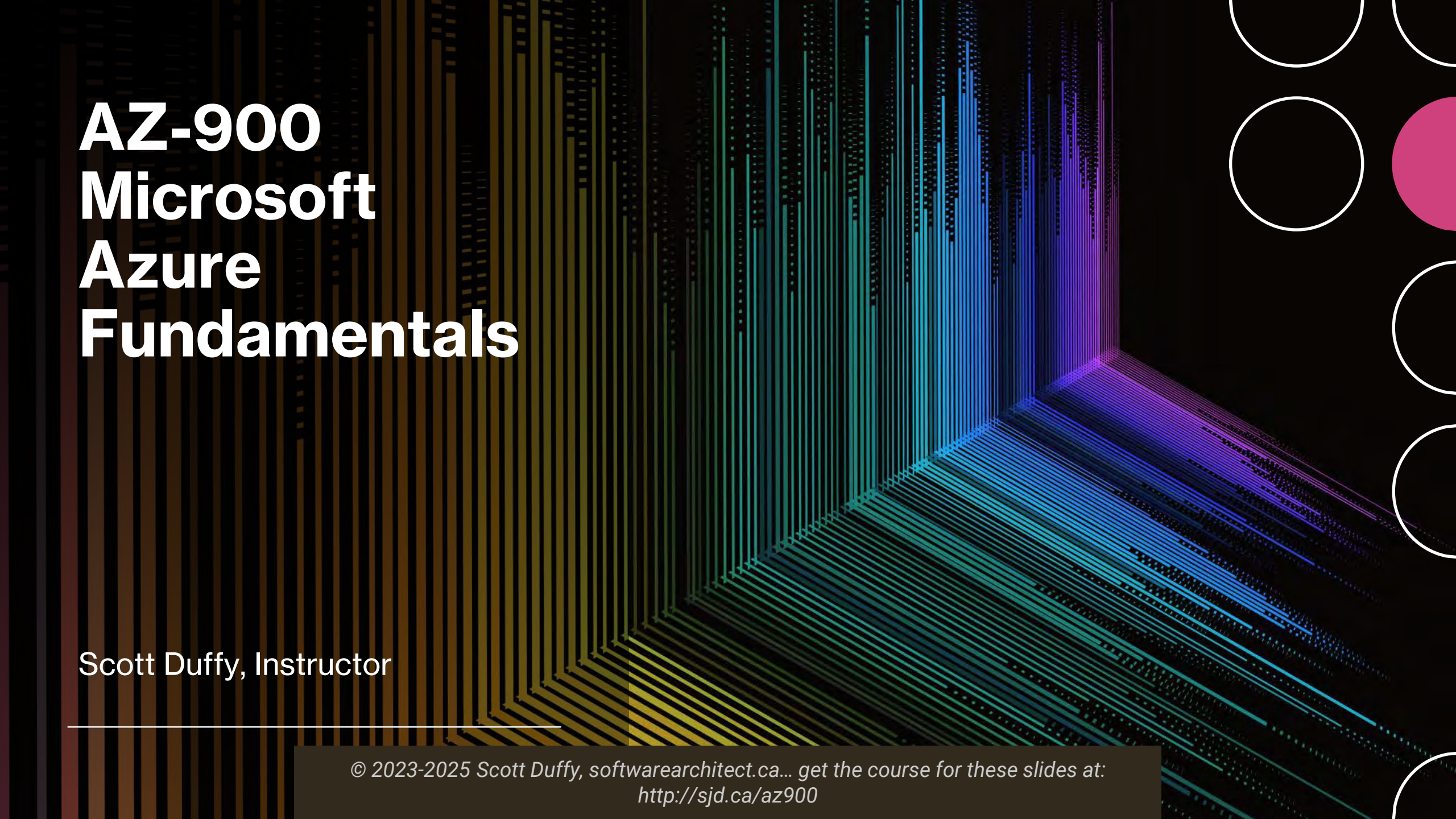

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Azure Data Centers




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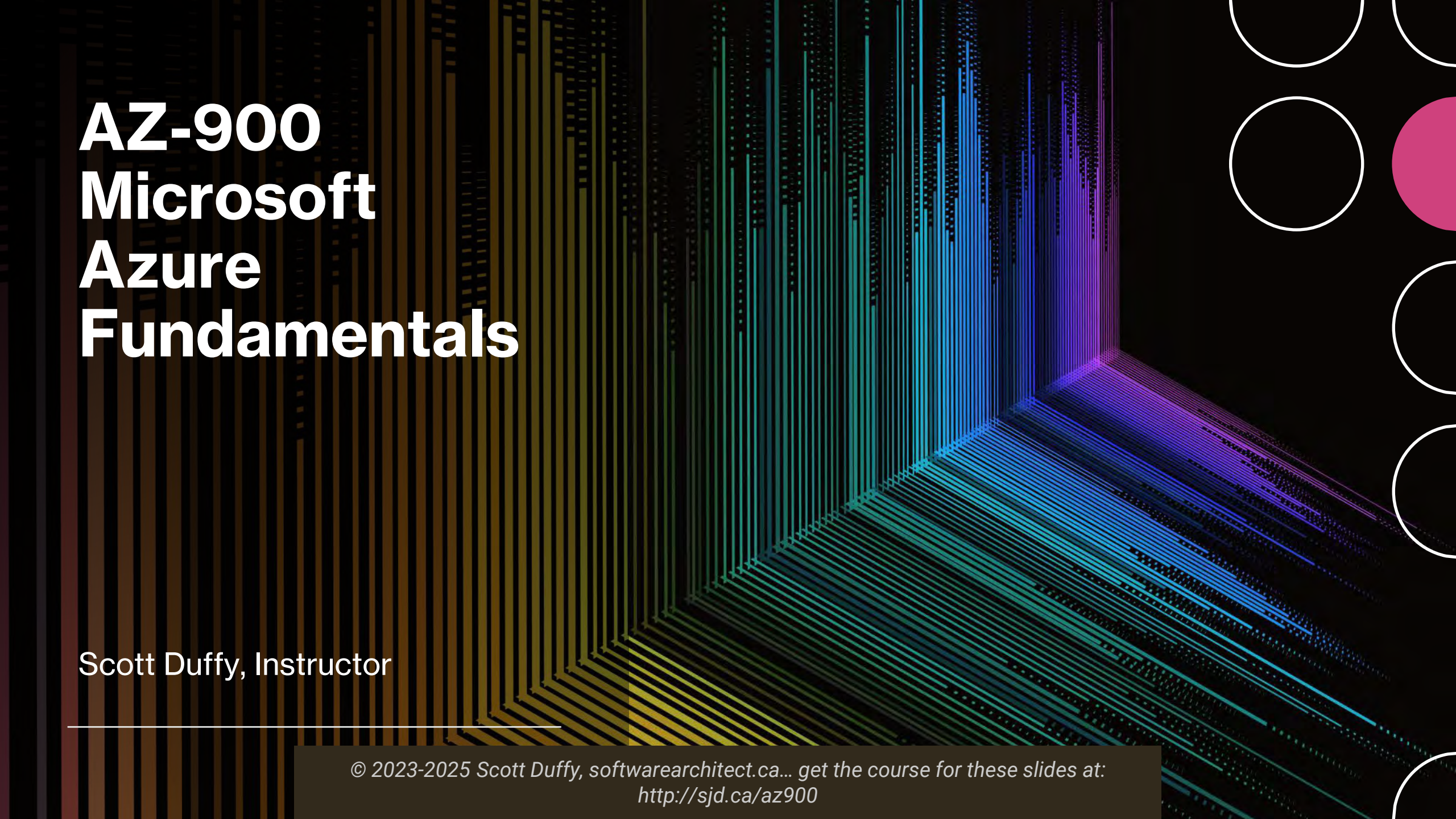

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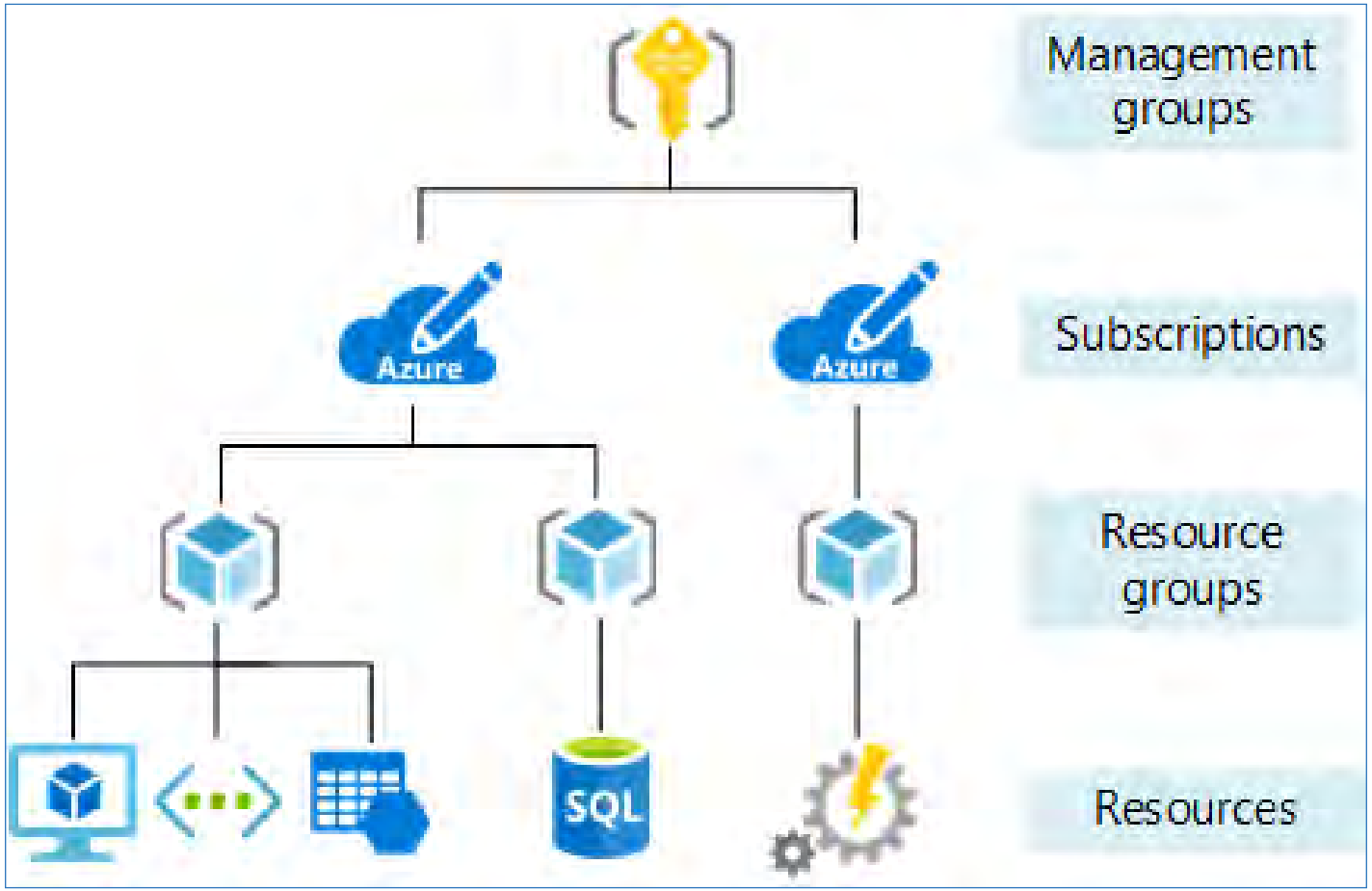
Resources & Resource Groups




Management groups
Azure
Azure
Subscriptions
Resource groups
SQL
Resources

Resources

- A generic word to represent an Azure service that you have access to, such as a specific Virtual Machine, Account, or Database

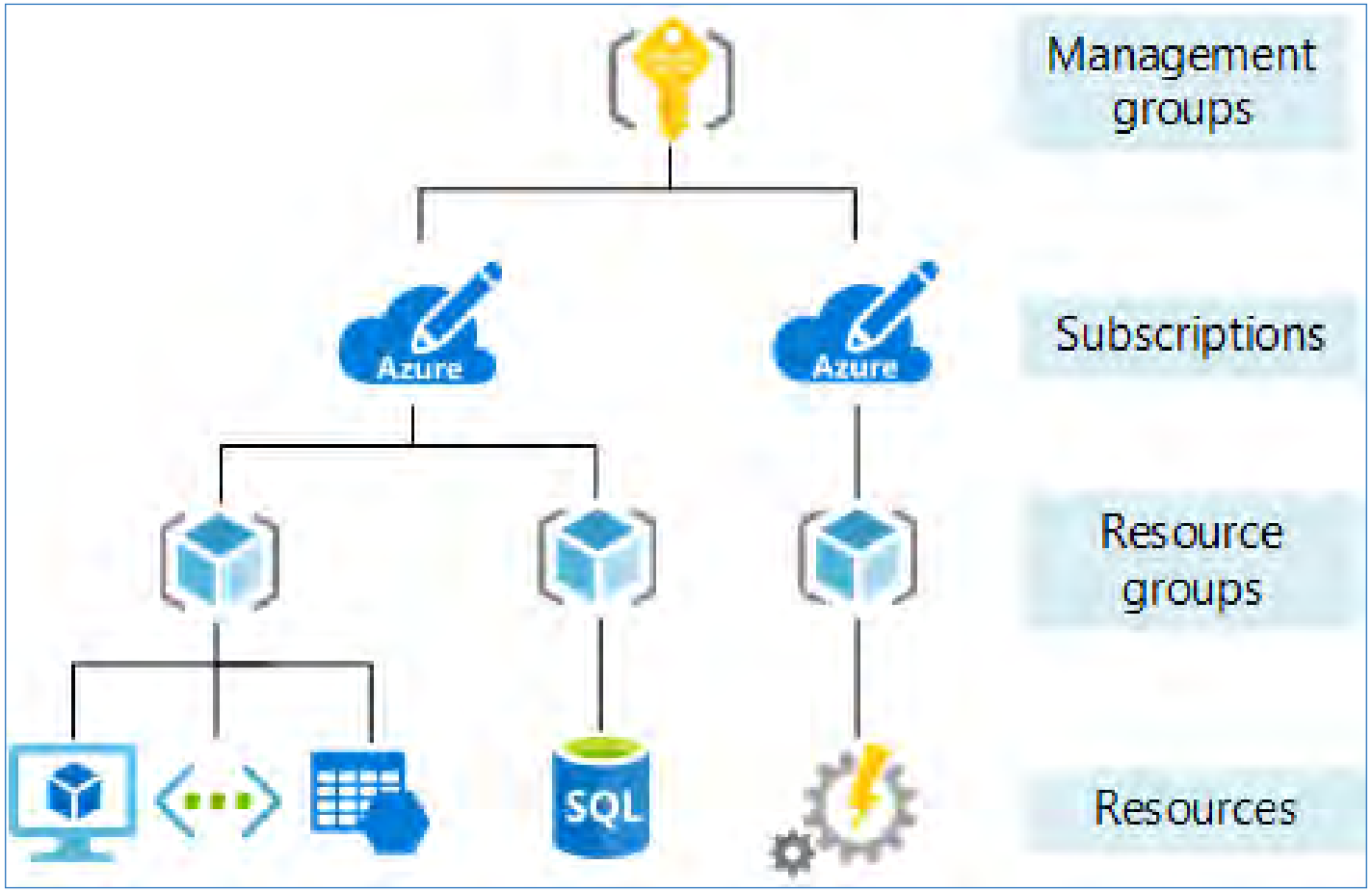
- You can create a resource in many different ways – Azure Portal, CLI, PowerShell, ARM Template, etc.

Resources

- Each resource has a name created by you
- Sometimes it has to be unique, sometimes not
- Generally, you indicate the region where they are to be created

All Resources

- A brand new subscription is created with no resources
- Most resources have costs associated with them
- The resource is associated with one (and only one) subscription, to which its cost is billed


Management groups
Azure
Azure
Subscriptions
Resource groups
SQL
Resources

Resource Group

- A logical grouping of resources
- Resource Group associated with a region, which can be different than the resources it contains
- All services in a resource group should have a similar lifecycle – deploy together, delete together

Resource & Group

- All resources must belong to one and only one resource group
- Permissions can be assigned at the resource group level
- There is no security boundary offered by a resource group for communications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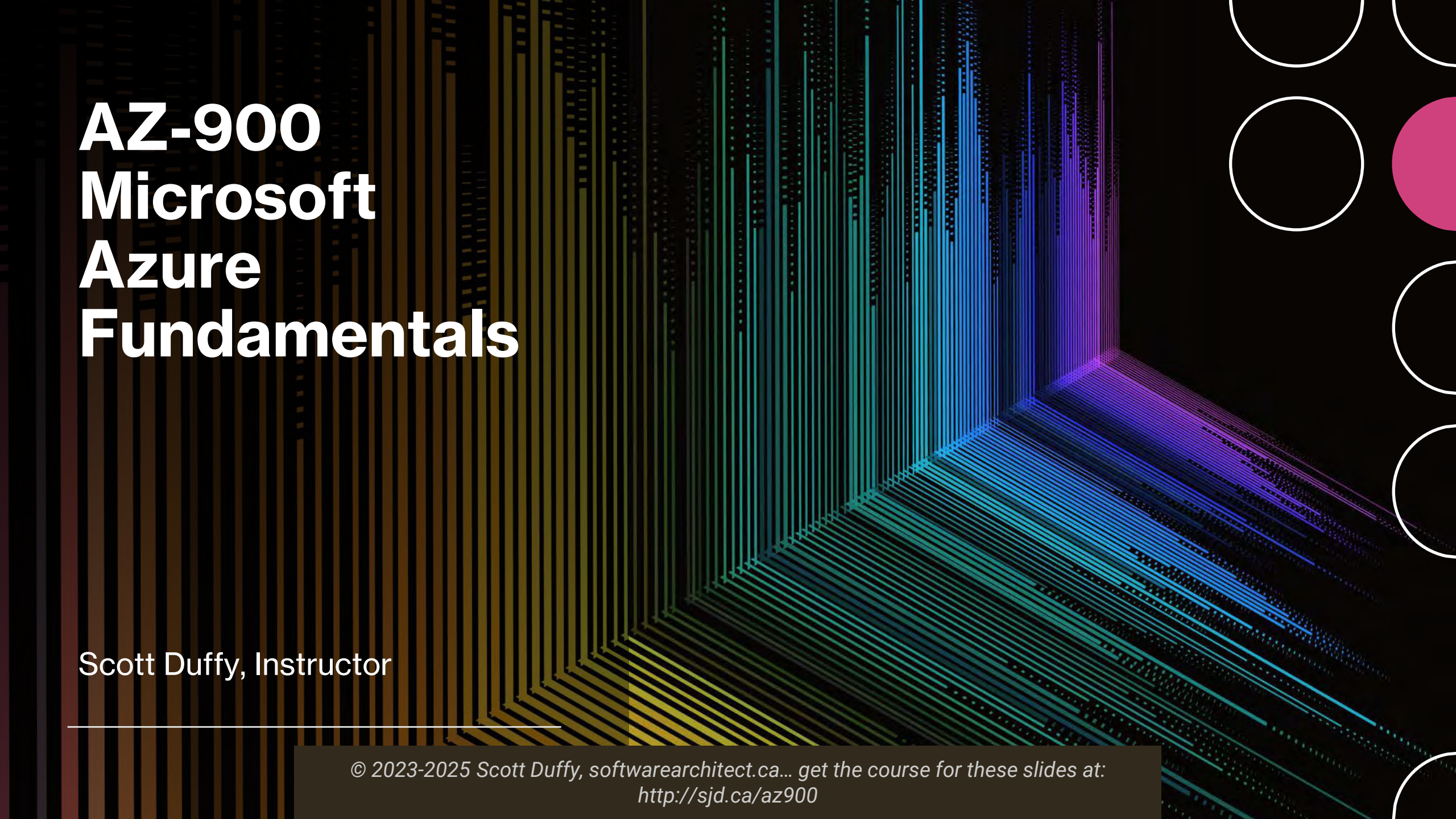

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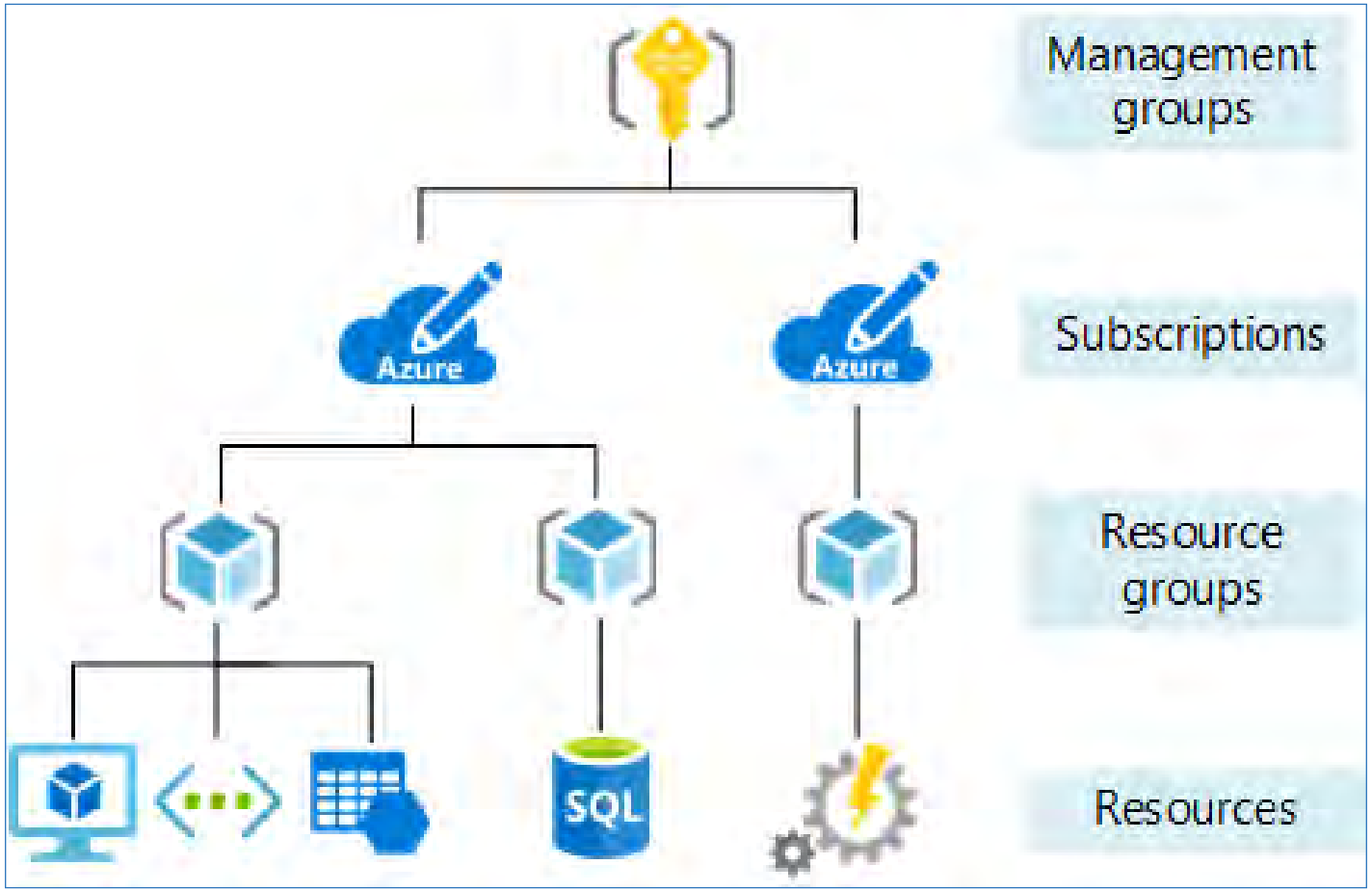
Subscriptions




Management groups
Azure
Azure
Subscriptions
Resource groups
SQL
Resources

Subscriptions

- The billing unit within Azure
- Administrative boundary for governance, compliance, and access control
- Every resource must exist inside one subscription
- Always a payment method associated with a subscription
- Users can have access to more than one subscription, and different roles

Subscription Plans

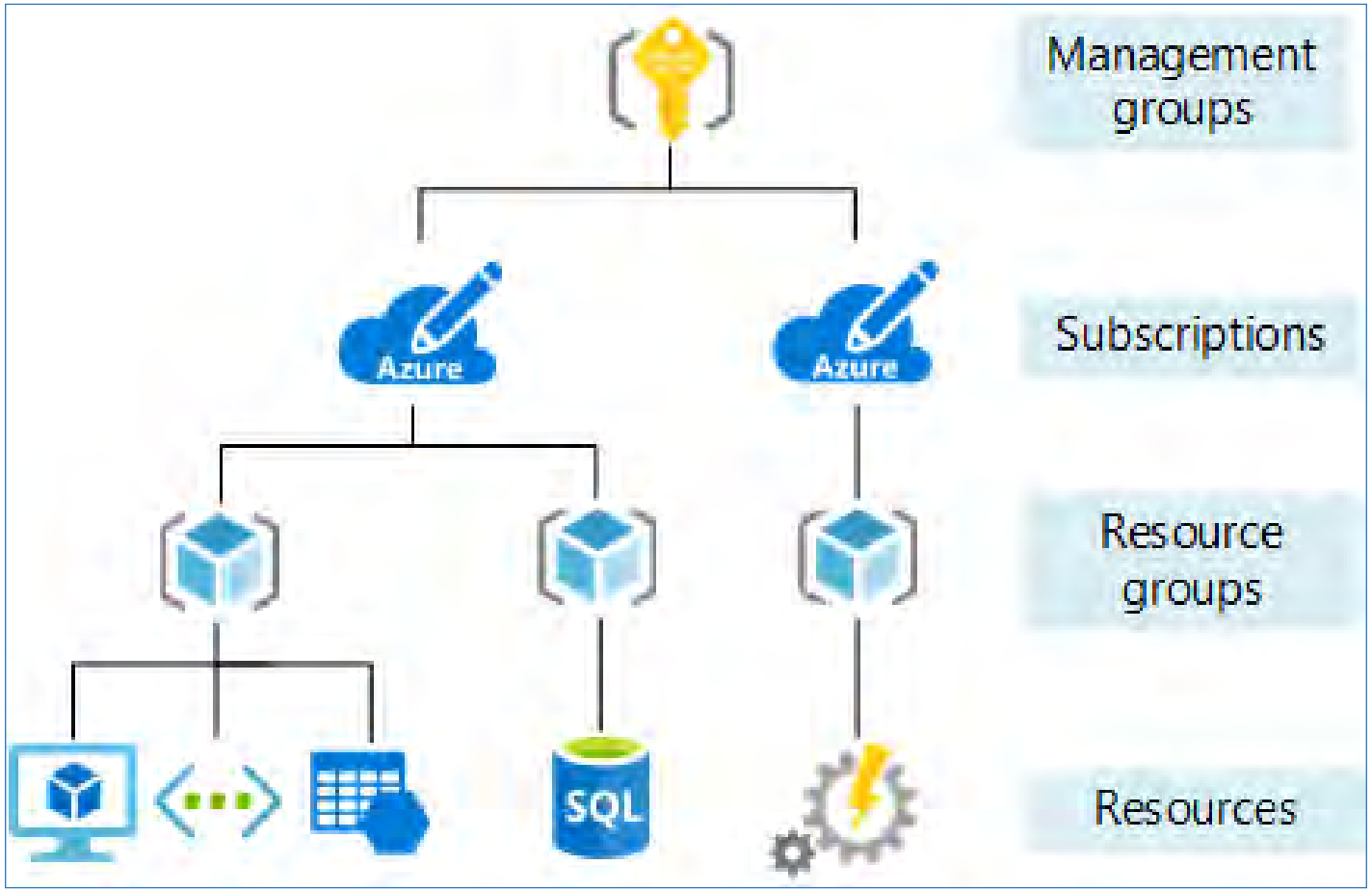
- Free plan - $200 credits first 30 days
  - can only have one
- Pay as you Go – billed to credit card
- Enterprise Agreement – EA
- Free credits – MSDN, Startup plans

Users

- A single user can have access to multiple subscriptions with different roles through Role Based Access Control (RBAC)
- If you’re not in a subscription, you can’t see its resources

Multiple Subscriptions

- Some companies can choose to have multiple subscriptions
- Can be used to separate out business units within an organization – e.g. Sales, IT, Finance
- Or separate by geography –
  e.g. North America, Europe, Asia


Management groups
Azure
Azure
Subscriptions
Resource groups
SQL
Resources

d > Subscriptions >

Pay-As-You-Go (Azure Courses)

Subscription

Can you help me with setting up cost alerts for this Subscription? | Check for outages affecting this Subscription. | +1

Search

- Overview
- Activity log
- Access control (IAM)
- Tags
- Diagnose and solve problems
- Security
- Resource visualizer
- Events
- Resource groups
- Resources
- Cost Management
- Billing
- Settings
- Help

Cancel subscription | Rename | Change directory | Feedback

Essentials

Subscription ID
7ad168af-d6a9-4286-a218-afc724130a43

Subscription name
Pay-As-You-Go (Azure Courses)

Directory
Default Directory (scottscourseoutlook.onmicrosoft.com)

My role
Owner

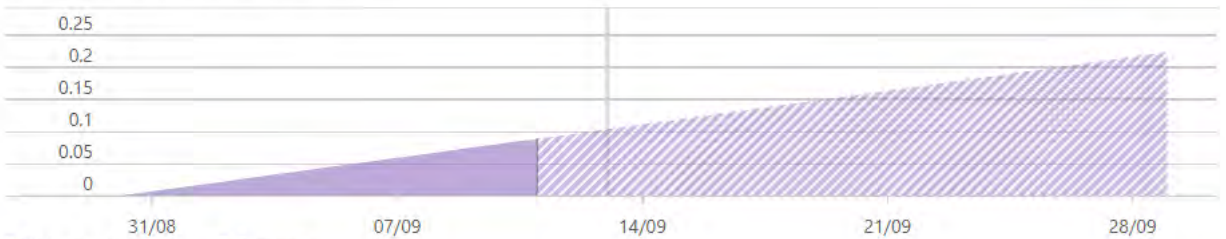
Status
Active

Plan
Azure Plan

Parent management group
eba4b1c9-bbec-4c83-878d-29a099d58533

Secure Score
Not available

Spending rate and forecast



Current cost
CA$0.09

Forecast
CA$0.22

View details

Costs by resource



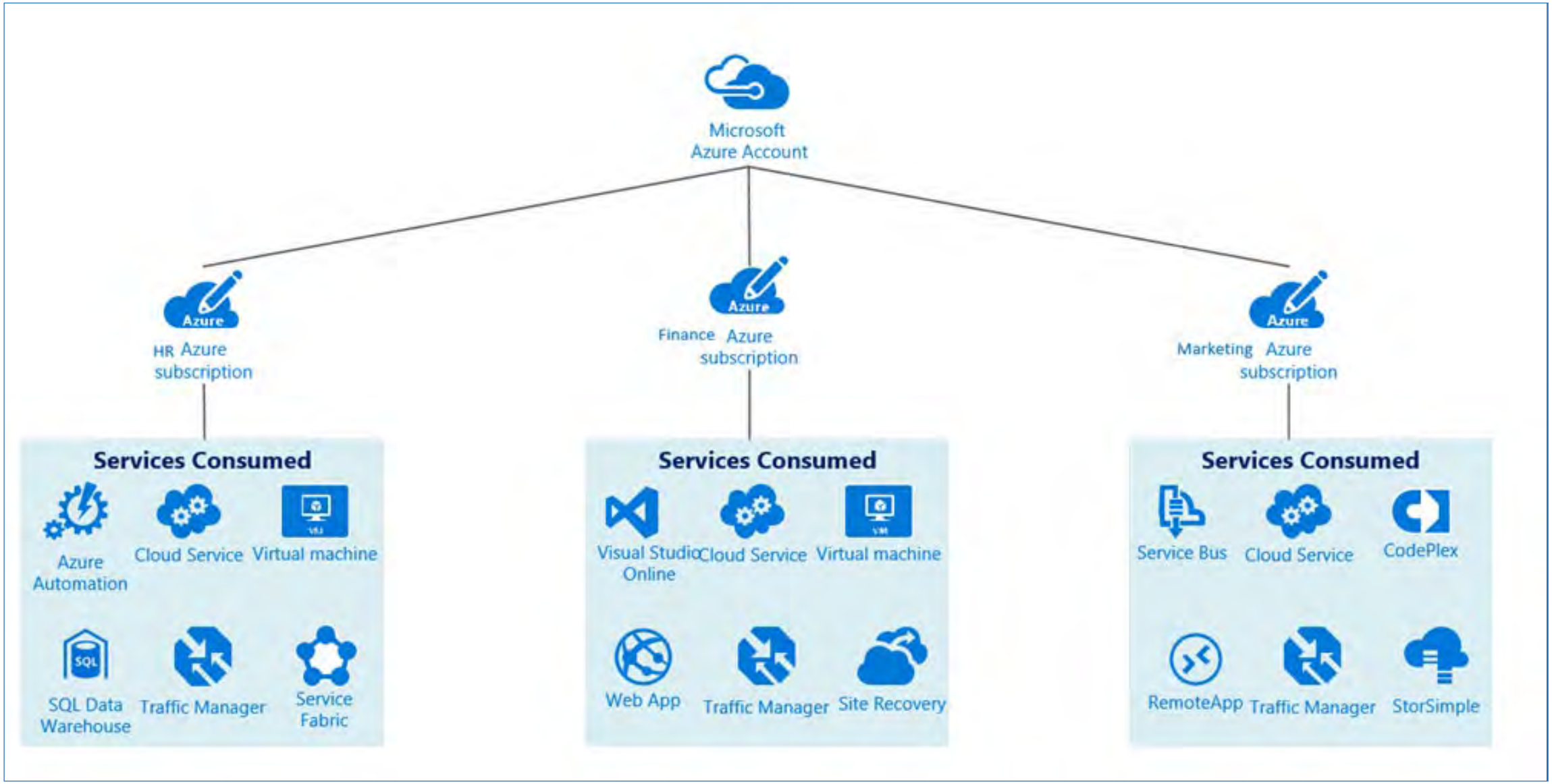
questiondb
CA$0.09

az900course
CA$0.01

sqlvaumdvm6v3n
CA$0.00

Others
CA$0.00

View details


Microsoft
Azure Account
Azure
HR Azure
subscription
Azure
Finance Azure
subscription
Azure
Marketing Azure
subscription
Services Consumed
Azure
Automation
Cloud Service
Virtual machine
SQL Data
Warehouse
Traffic Manager
Service
Fabric
Services Consumed
Visual Studio
Online
Cloud Service
Virtual machine
Web App
Traffic Manager
Site Recovery
Services Consumed
Service Bus
Cloud Service
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RemoteApp
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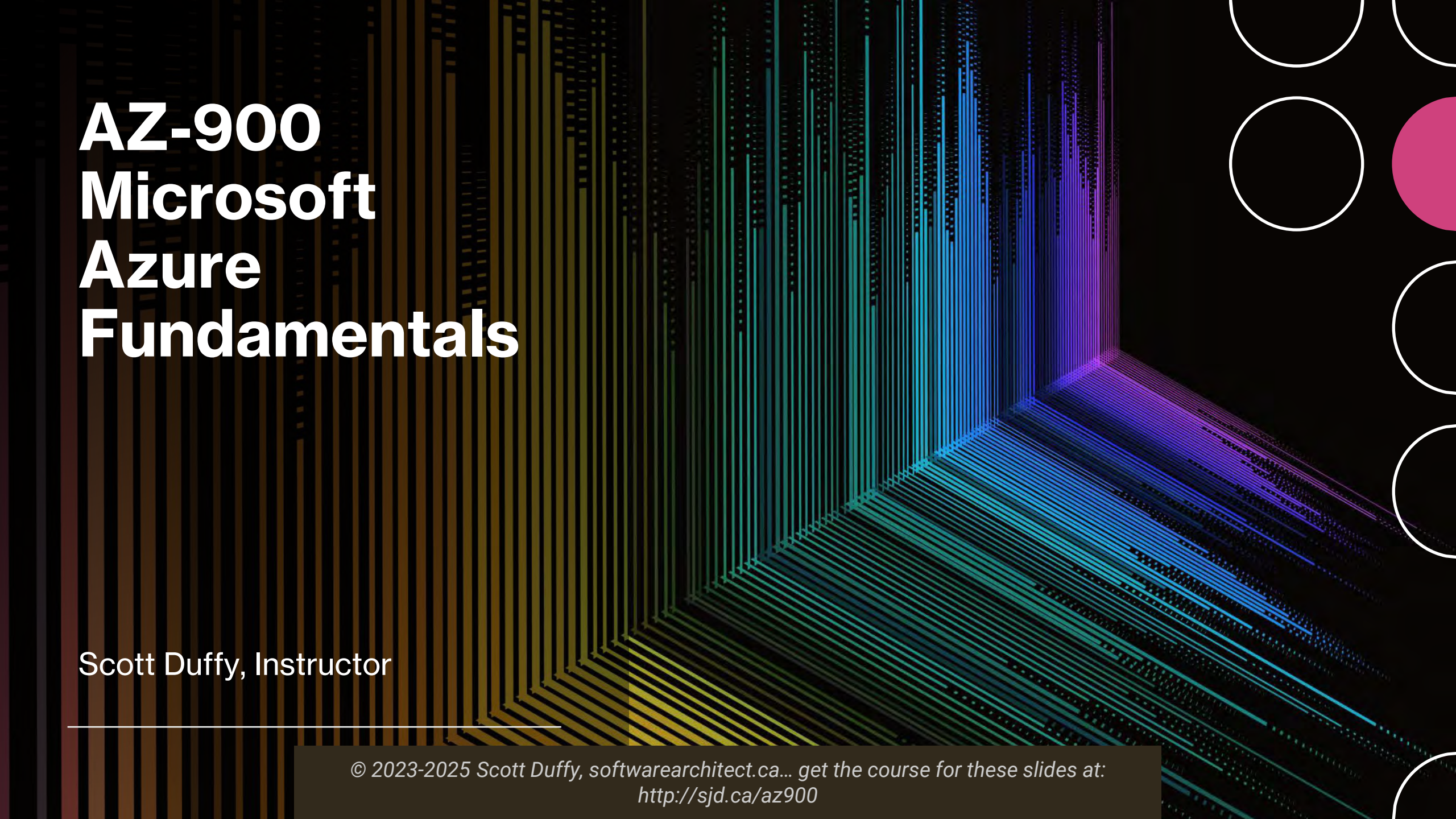

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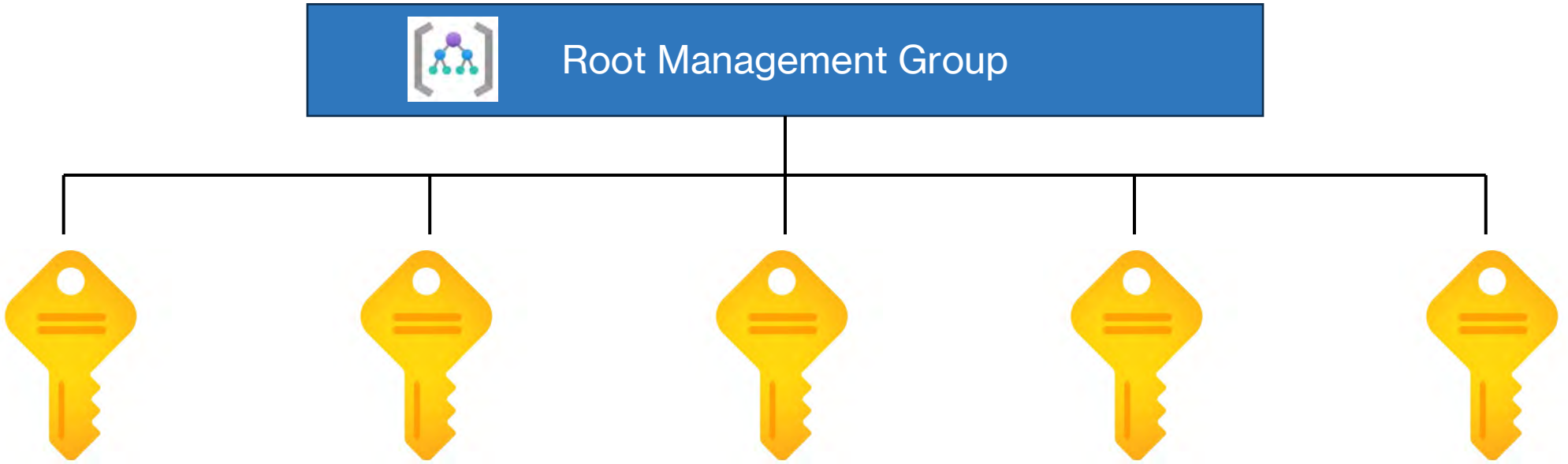
Management Groups



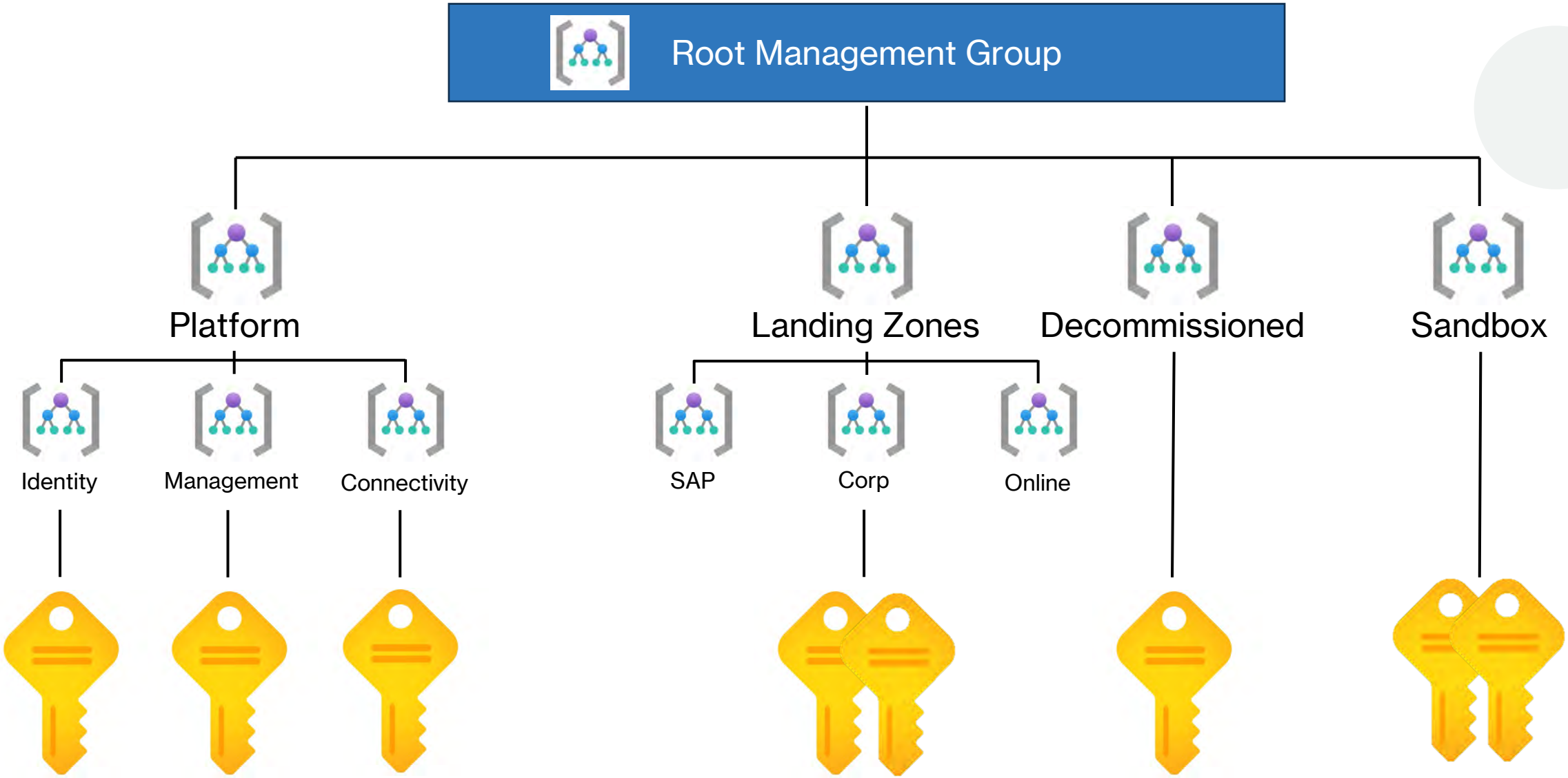
Multiple Subscriptions



Contoso Inc.



Contoso Inc.


Root Management Group
Platform
Landing Zones
Decommissioned
Sandbox
Identity
Management
Connectivity
SAP
Corp
Online

Purpose of Management Groups

- Group subscriptions into a hierarchy and manage them at scale
- Apply policies, RBAC, and governance settings once at the top level – inheritance
- Enforce consistent standards across departments
- Organize large Azure environments into clean, predictable structure to simply compliance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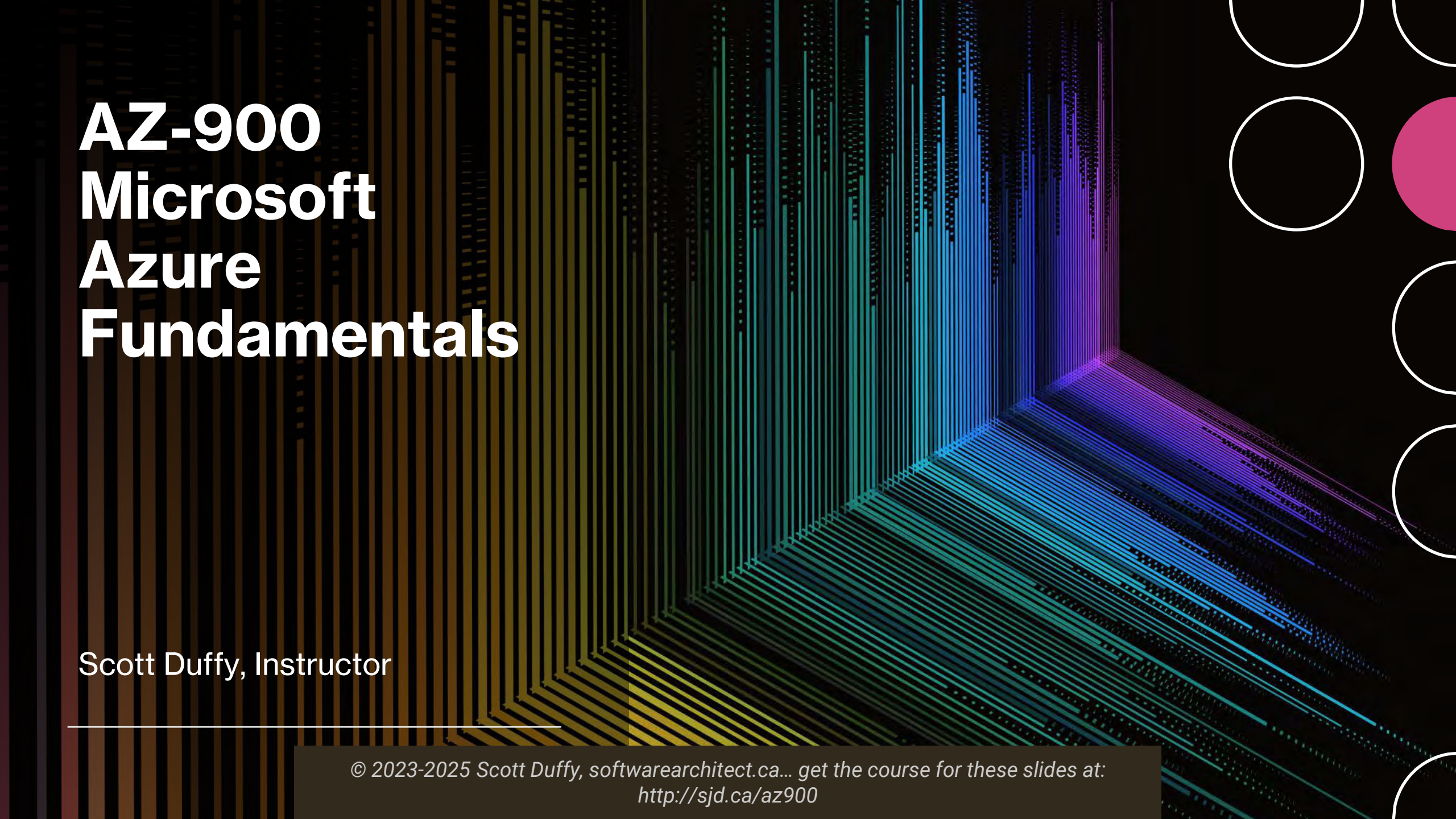

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Scott Duffy, Instructor

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Describe Azure architecture and services (35–40%)

Describe the core architectural components of Azure

- Describe Azure regions, region pairs, and sovereign regions
- Describe availability zones
- Describe Azure datacenters
- Describe Azure resources and resource groups
- Describe subscriptions
- Describe management groups
- Describe the hierarchy of resource groups, subscriptions, and management groups

Describe Azure compute and networking services

- Compare compute types, including container instances, virtual machines (VMs), and functions
- Describe VM options, including Azure Virtual Machines, Azure Virtual Machine Scale Sets, availability sets, and Azure Virtual Desktop
- Describe resources required for virtual machines
- Describe application hosting options, including the Web Apps feature of Azure App Service, containers, and virtual machines

- Describe virtual networking, including the purpose of Azure virtual networks, Azure virtual subnets, peering, Azure DNS, Azure VPN Gateway, and ExpressRoute
- Define public and private endpoints

Describe Azure storage services

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- Describe the concept of Zero Trust
- Describe the purpose of the defense-in-depth model
- Describe the purpose of Microsoft Defender for Cloud

Technical Pillars of Azure

- **Compute services**
- **Networking services**
- services
- Database services

Compute Services – “Executing code” in the cloud

Compute Types in Azure

- Virtual Machines (VM)
- VM Scale Sets (VMSS)
- App services (Web apps)
- Azure Container Instances (ACI)
- Azure Container Apps
- Azure Kubernetes Service (AKS)
- Azure Virtual Desktop

Virtual Machines

- This is the closest analogue to a “server” in cloud computing
- But it’s **virtual**
- That is, a single physical machine has been subdivided into slices and you get to rent a single slice of it

Standalone Server Analogy

- Think of a **standalone self-hosted server** as a single-detached house
- You can do whatever you want with it (generally)
- It’s very difficult to do anything that affects your neighbors (soundproof walls)
- You don’t share any services with your neighbors besides garbage, sewer, water, electricity – provided by the city

Virtualization Analogy

- Think of a **host** as an apartment building on the same land
- And a **virtual machine** as an apartment in that building
- You're using common services like garbage, sewer, water, electricity – provided by the landlord (Azure)
- Other services available like shared gym, heating/cooling, landscaping and snow removal
- It's generally cheaper to rent an apartment than a house
- When you're inside the apartment, it's hard to tell that it's not a house

Virtual Machines

- Infrastructure as a service - IaaS
- Take an existing machine from your environment into the cloud - a copy
- Windows or Linux operating systems - several of each
- A “slice” of a physical machine shared with other customers
- Full control over it, as if it was your machine

In AWS, a Virtual Machine is called Elastic Compute Cloud (EC2).

Virtual Machine Types

- Over 700 to choose from
- Number of CPU cores, CPU speed, RAM size, temporary disk size, IOPS, etc

Scaling Azure VMs

- You can increase the size of a VM easily, turning a 4 vCPU VM into an 8 vCPU VM in minutes (scale up)
  - Can go to 64 vCPUs or higher
- OR you can add more VMs and have them work together to handle the work (scale out)

Virtual Machine Scale Sets

- A group of virtual machines that can grow and shrink in quantity based on a predefined rule

- Usually based on monitoring demand
- Can be based on time (schedule)
- Can be based on many other factors

VM Scale Sets

- Elasticity
- **Two or more virtual machines running the exact same code**
- With a “load balancer” in front to direct traffic randomly to one of the machines
- Able to add more machines as demand grows (autoscaling)
- Able to reduce machines as demand slows
- Can handle up to 100 VMs in a single scale set
- Can be configured to increase that to 1000 VMs in a single scale set
- If you need more, you can create more scalesets

App Services (Web Apps)

- A new paradigm for running code in the cloud
- Give your code and configuration to Azure, and they will run it
- Promise of performance but no access to hardware
- Platform as a Service (PaaS)

Container Services

- Another paradigm for running code in the cloud
- Containers contain everything the app needs to run in a “container image”
- Fastest and easiest to deploy
- **Azure Container Instance (ACI)** - single instance, quickest way to deploy a container
- **Azure Container Apps** - easy to use like a web service, with advanced features
- **Azure Kubernetes Service (AKS)** - runs on a cluster of servers, enterprise-grade

Azure Virtual Desktop

- Desktop version of Windows that runs in the cloud
- Your software installed, your files - available from anywhere
- Can even see your desktop on iOS and Android, or from any web browser
- Runs on Azure


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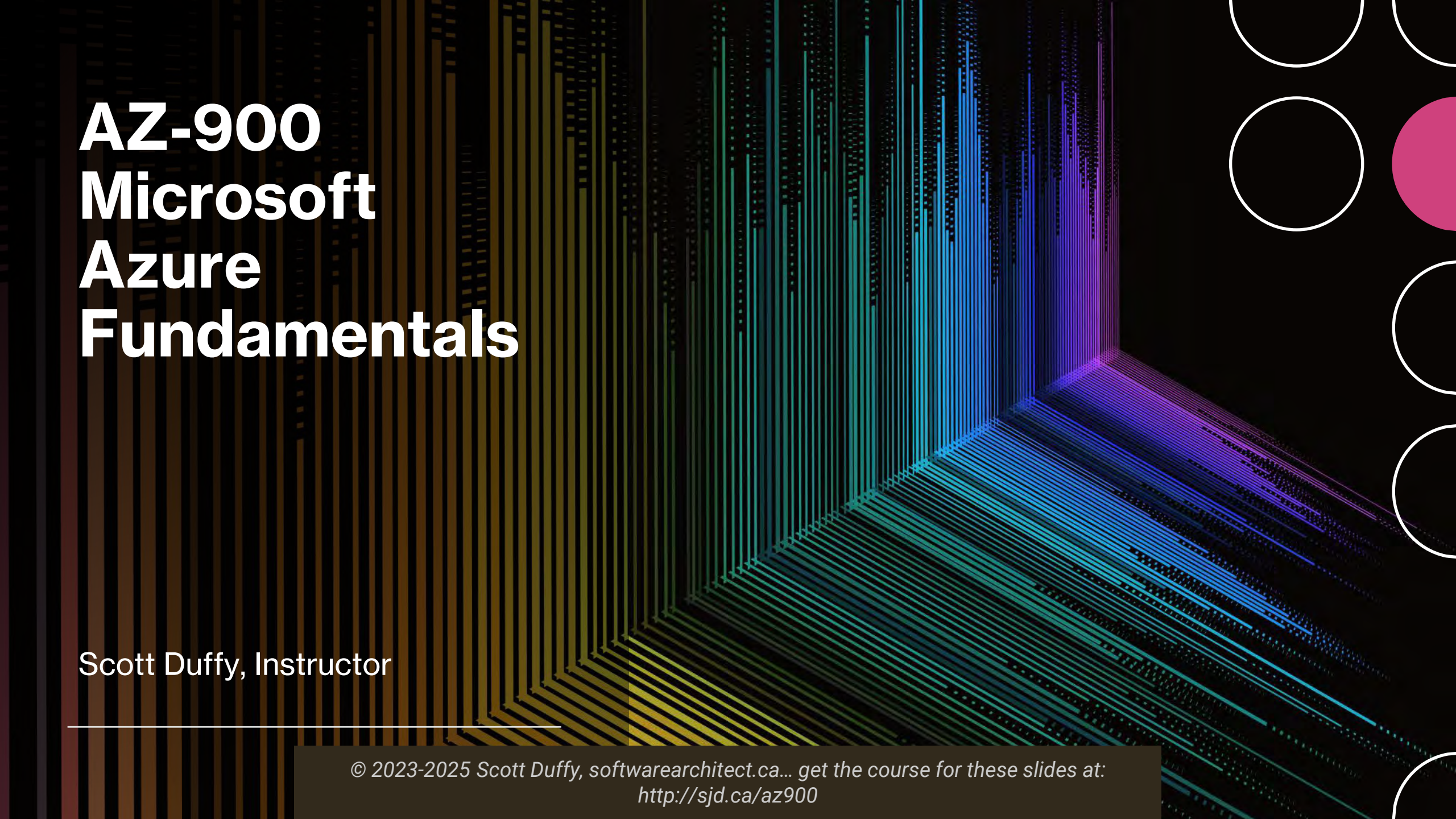

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Availability Sets and Proximity Groups



Availability Sets

- You have multiple Virtual Machines that have an identical function
- You want to signify to Azure that they should be separated from each other in a certain way
- Fault isolation
  - Fault domain and update domain
  - Separate power sources and network switches
  - Updated one at a time, not all together

Proximity Group

- You have multiple Virtual Machines that have an identical function
- Arranged in a Virtual Machine Scale Set
- You want them placed close together
- Trade-off: less availability for more performance
- Fastest inter-server communication


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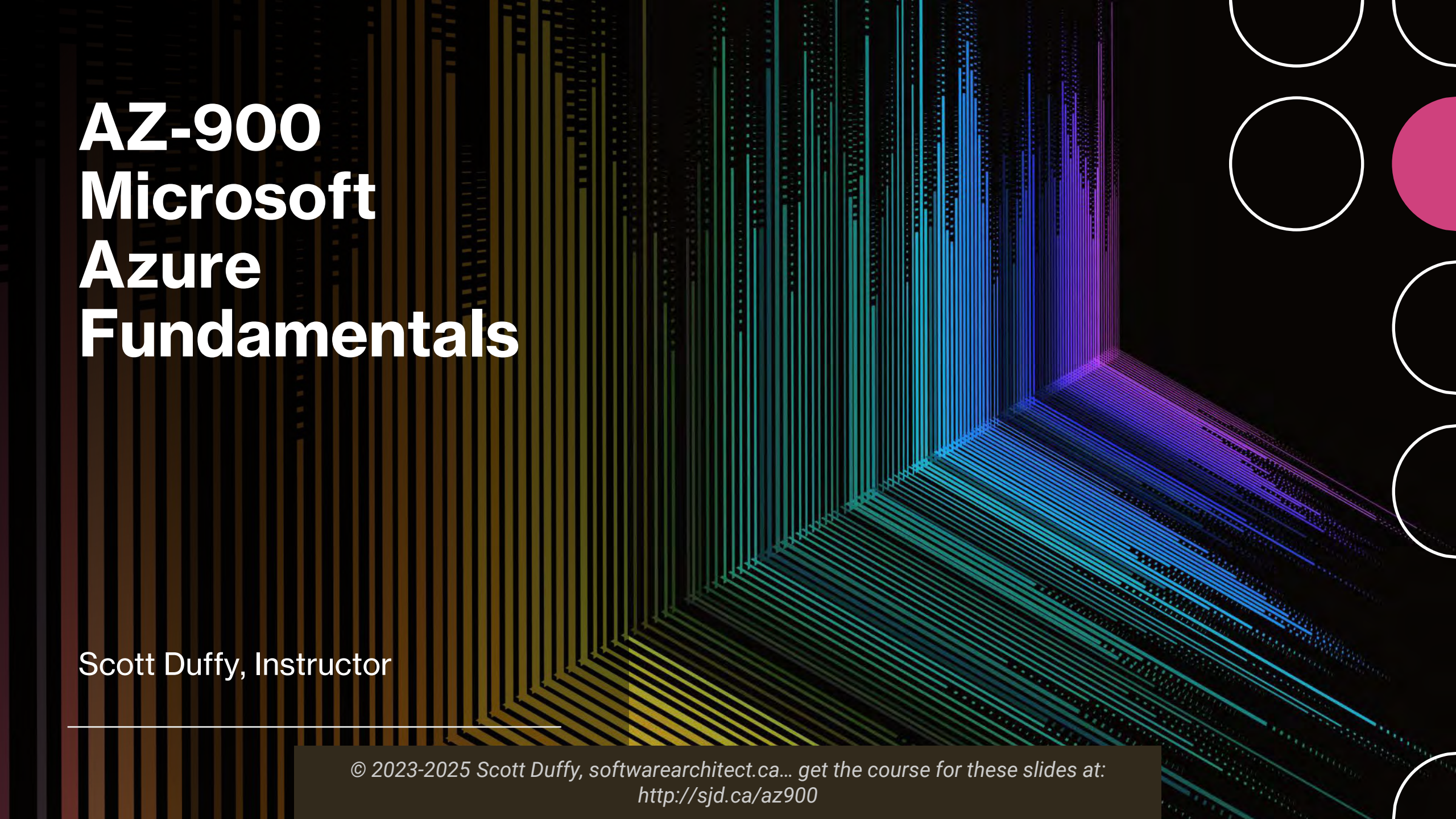

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Functions


mirror_mod.mirror_object
operation == "MIRROR_X":
mirror_mod.use_x = True
mirror_mod.use_y = False
mirror_mod.use_z = False
operation == "MIRROR_Y":
mirror_mod.use_x = False
mirror_mod.use_y = True
mirror_mod.use_z = False
operation == "MIRROR_Z":
mirror_mod.use_x = False
mirror_mod.use_y = False
mirror_mod.use_z = True
selection at the end -add
_ob.select= 1
er_ob.select=1
ntext.scene.objects.acti
("Selected" + str(modifie
irror_ob.select = 0
bpy.context.selected_ob
ata.objects[one.name].se
int("please select exactl
OPERATOR CLASSES
types.Operator):
X mirror to the selected
ject.mirror_mirror_x"
ror X"

Azure Functions

- Small pieces of code that run entirely in the cloud
- Utility function – does something specific in a finite amount of time
- Is triggered by something happening
  - HTTP call, timer, blob creation, message queue, ... other
- Very inexpensive

Azure Functions

- Free tier – one million executions per month free
  - Serverless model
- Can support more complicated designs
  - Durable functions
  - Long-running functions
  - Premium or dedicated hosting options

Examples of Functions

- A small piece of code that runs every day at 12am, and summarizes yesterday's data
- A small piece of code that checks a blob container for new files, and does something every time it finds a new one
- A small piece of code that runs every 6 hours, and retrieves the latest weather forecast from a publicly accessible weather API


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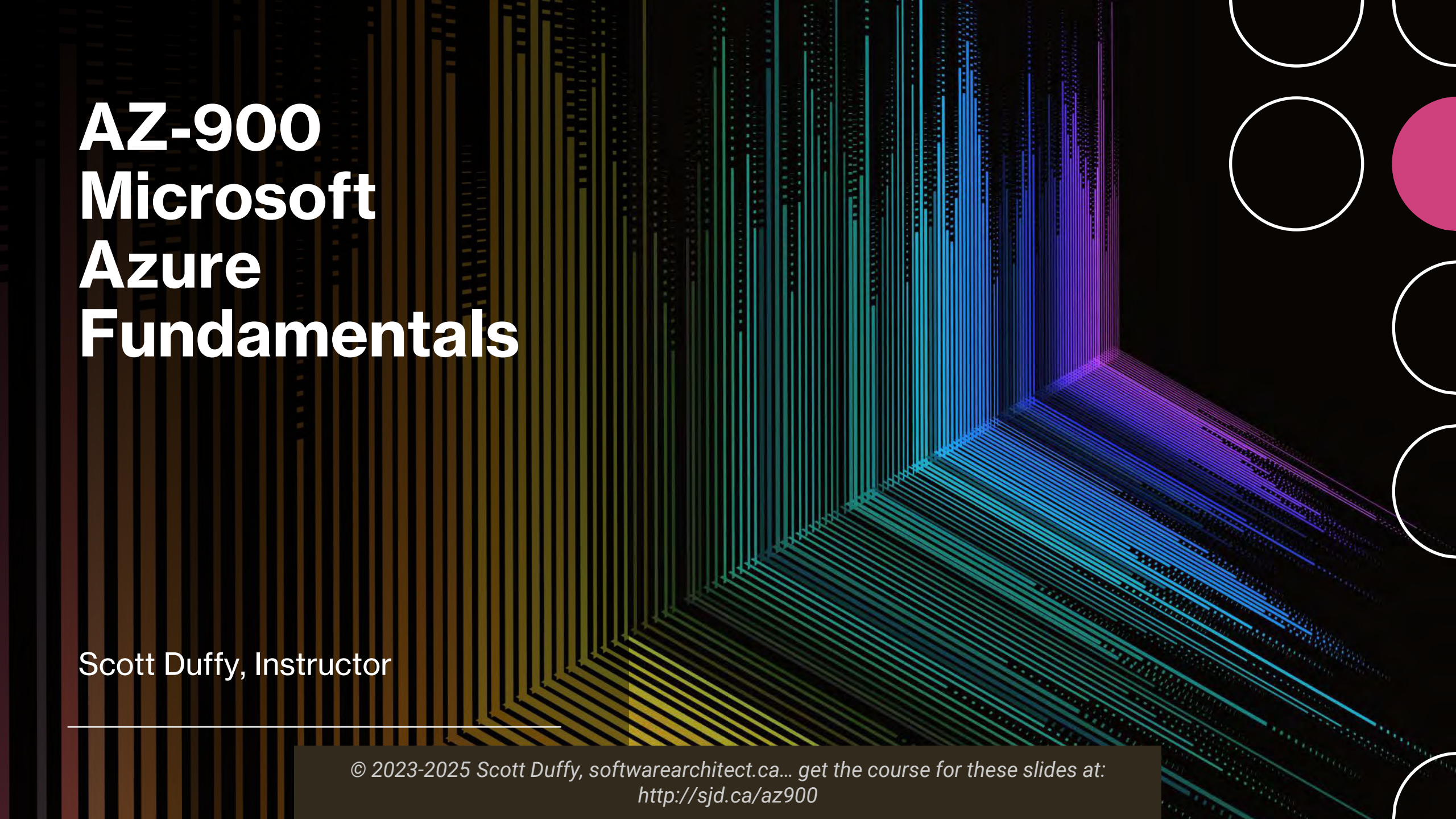

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Virtual Networking in Azure

- Sometimes called VNets
- Microsoft has an extensive global network of cables, switches and routers – physical network
- We saw “the globe” of Microsoft’s network at the beginning of the course

Virtual Networks

- By default, two virtual machines in Azure are not allowed to talk with each other – security!
- Virtual networks have an analogue to the physical networks we would set up in our own office or data center – infrastructure as a service (IaaS)
- In Azure, it's virtual because it's effectively just a database entry in a table that establishes the path between VM A and VM B

VNets

- Virtual Networks are assigned an address space of either IPv4 or IPv6 addresses, or both
- These are private addresses, which cannot be accessed from outside of Azure or other networks inside of Azure
- A single VNet is usually assigned a large quantity address space to support potential future growth
- There is no shortage of private IP addresses

Subnets

- All VNets are subdivided into one or more subnets
- The subnet is assigned a range of IP addresses which must exist in the address space of the parent VNet
- Usually there is a security layer between subnets; traffic must match a predefined ruleset to pass

Virtual Machines

- All virtual machines must belong to at least one subnet, using a Network Interface Card (NIC)
- Some VMs have more than one NIC and can connect to more than one subnet
- VMs can optionally be assigned a public IP, which makes it eligible to be accessed from outside Azure (subnet to security/firewalls)

Network Security Group

- Also called an NSG
- An access control list (ACL) that blocks traffic inbound and outbound from a subnet unless it matches certain rules
- The rules are based on source IP, source port, destination IP, destination port, and protocol (5-tuple match)

NSGs

- You can allow communication between different subnets on the same network through adding specific NSG rules
- No traffic passes the NSG filter unless an “ALLOW” rule matches
- Rules have priorities, and the highest priority rule that matches is the one that applies

Peering

- Communication is blocked between two subnets on different networks
- Connecting two subnets together is called peering
- This allows communication between a VM on one network and a VM on a different network

Azure DNS

- DNS stands for Domain Name System
- You can give your IP addresses names using a DNS
- DNS only applies internally to Azure to applied networks



Example of Azure DNS

- http://development.local
- http://database.local
- http://staging1.local
- http://dev.mydomain.com

Azure VPN Gateway

- VPN is Virtual Private Network
- Allows communication between a workstation and a network, or between two networks
- Encrypts traffic between those two points

VPNs

- Outside of Azure, VPNs require a physical device to be installed on a network
- Inside of Azure, you can install a VPN Gateway as a virtual device on your network
- VPN Gateway requires its own subnet

Work from Home

- If you work from home, you might need to use a VPN to connect to the office network
- This is called “point to site” VPN or (P2S)
- Your desktop computer is the “point” and your company’s network is the “site”

VPN Peering

- You can also connect two distant networks using VPN devices
- This is called “site to site” VPN, or S2S
- Can connect an entire office of computers to an Azure subnet, or two offices together

ExpressRoute

- If communicating into Azure at high speeds is important to you, you might want to look into ExpressRoute
- A private connection from your ISP to an Azure endpoint
- Bypasses the public Internet


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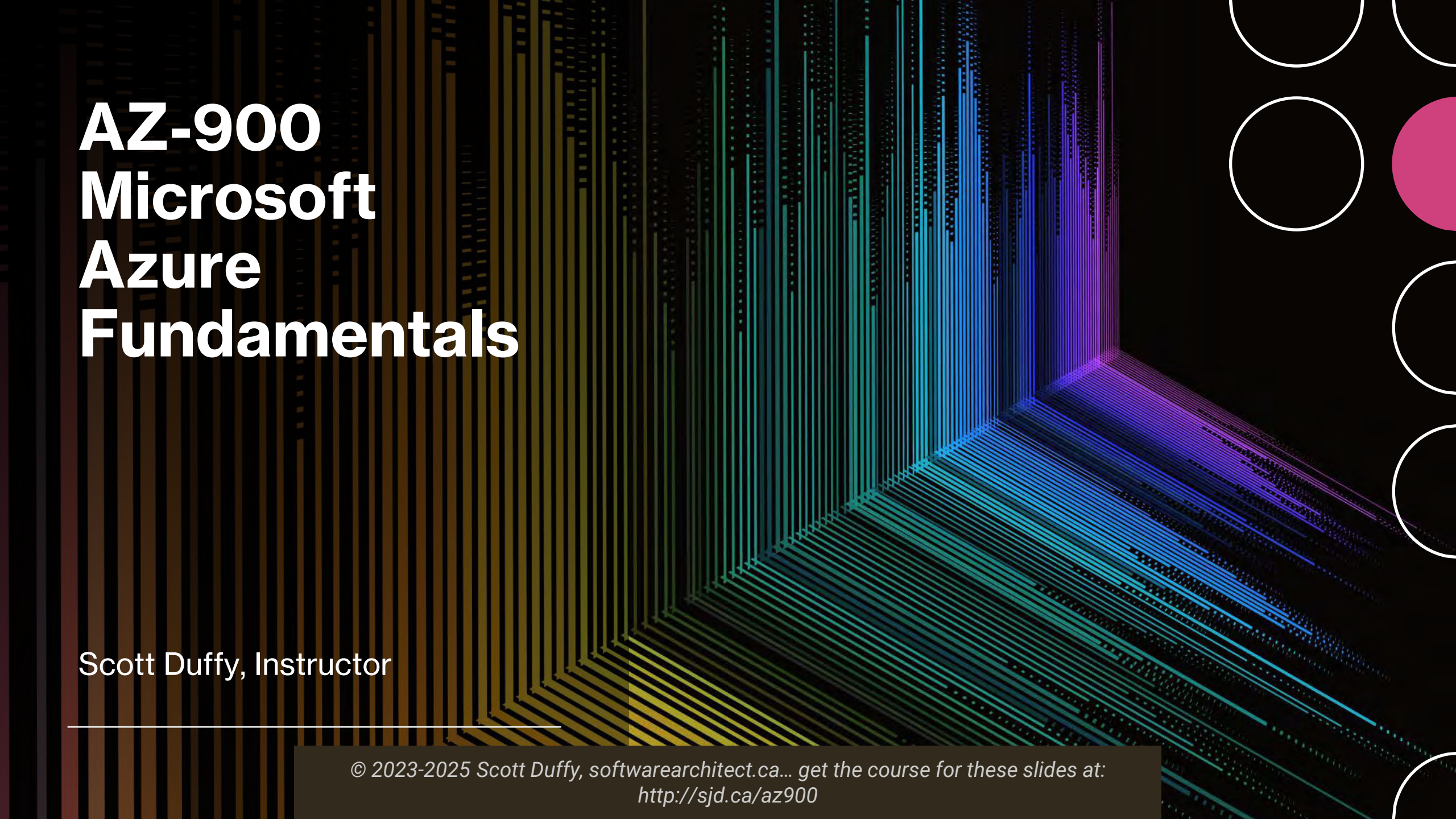

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Public and
Private
Endpoints

Comparing Endpoints

Public Endpoint With Internet Access

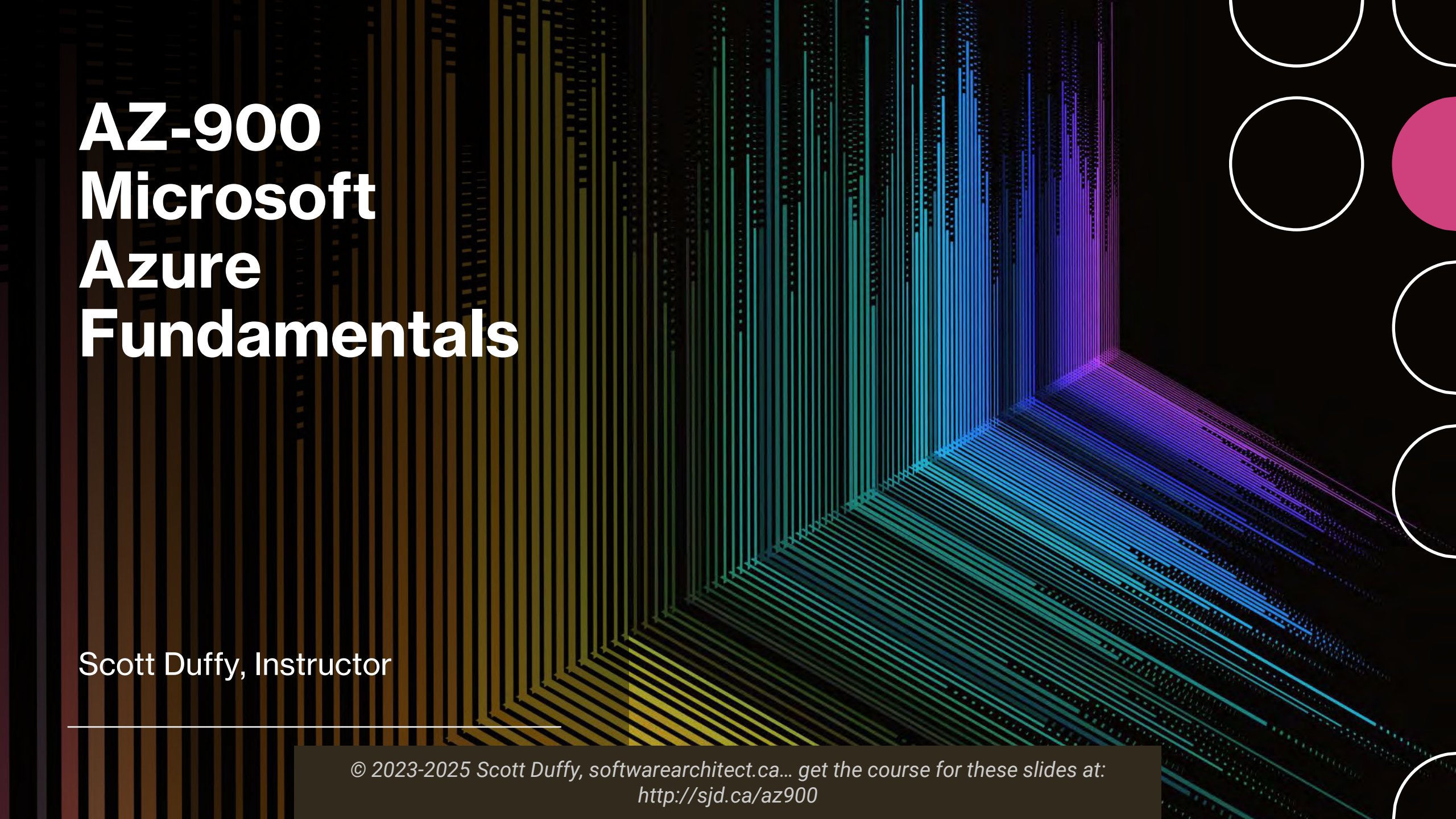
- Public IP
- Accessible from anywhere on the Internet
- Traffic can go to the public Internet (SSL)

Public Endpoint Plus Specified Network

- Public IP
- Accessible from Internet **and** selected networks
- Traffic from selected networks stays in Azure
- Can filter IP ranges

Private Endpoint

- Private IP
- Accessible only from within you Vnet
- Traffic never travels the public Internet



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Services

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Azure Services

- Container (Blob)
- Disk – for Virtual Hard Disks (VHDs)
- Azure File
- tiers

- Infrastructure as a Service (IaaS)

Azure (GPv2)

- “Standard ”
- Subdivided into four types of data it can store
  - Container, File, Queue, Table
- Can hold up to 5 Petabytes (5PB) = 5 million GB
- Pay for what you use
- ~2 cents per GB per month
- Extremely cheap cloud
- Not recommended for high-demand workloads

Data Lake

- A setting when creating a GPv2 acct
- A data lake is extremely large
- Can hold petabytes and exabytes
- Good for “big data” analytics

Premium Options

- Blob – can only hold containers (blobs)
  - Can choose block blobs or page blobs
- File
- Uses premium SSD (solid state disks)
- Triple the “operations per second (OPS)”
- Lower latency (time to first byte)
- More expensive, obv

High Performance

- Premium SSD
- Premium SSD v2
- Ultra Disk


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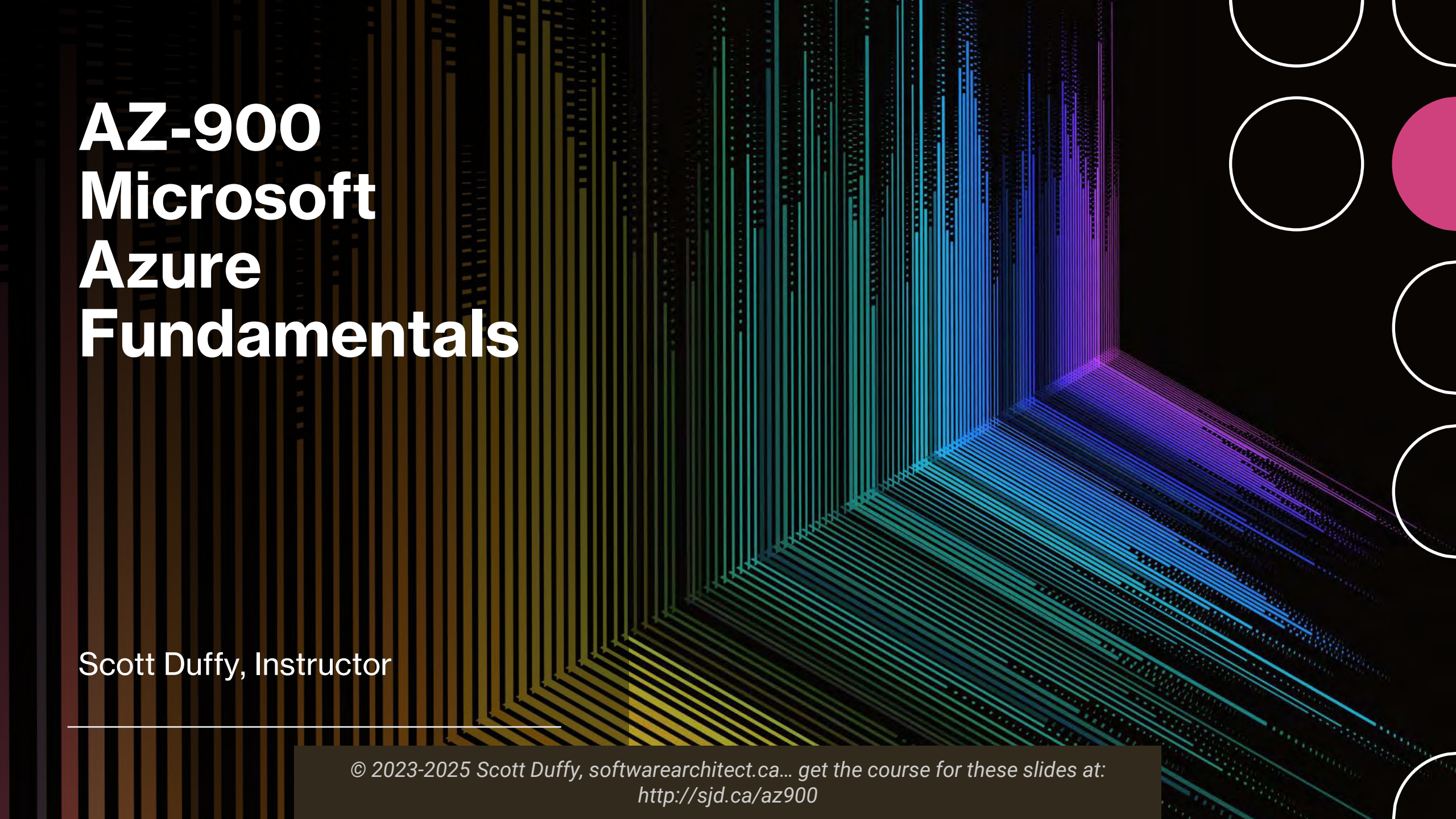

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Container

Binary Large Object (BLOB)

- These are files of any type (TXT, PDF, ZIP, CSV, XLSX, JPG, AVI, ... whatever)
- Stored loosely in a container
- Public or private
- “Unstructured data”



Container

- Create multiple containers
- Each container can contain blobs
- Can be organized into folders (yes and no)
- Only pay for what you use



A account in AWS is called Simple Service (S3)

Location

- You can create multiple accounts in any region of the world
- Keep your data close to the person/service consuming it (for access speed reasons)
- Price varies by region

Redundancy

- Azure keeps 3 copies of your data by default
- Locally- or zone-redundant
- Azure will almost never, ever lose a file once it’s successfully received it

Global Redundancy

- You can choose global redundancy for
- Azure keeps 6 copies of your data
- 3 locally, and 3 in another region of the “geo”
- Honors data sovereignty laws



Access Tiers

- Four access tiers
  - **Hot** – the default, balanced access
  - **Cool** – can be set as default, cheaper with more expensive read/write operations
  - **Cold** – much cheaper , more expensive read/write operations
  - **Archive** – cannot get immediate access to files, cheapest , most expensive operations



Failover

- Hard disks fail every so often
- Azure takes care of this without you doing anything
- 3 copies of your data, they can recreate a hard disk behind the scenes


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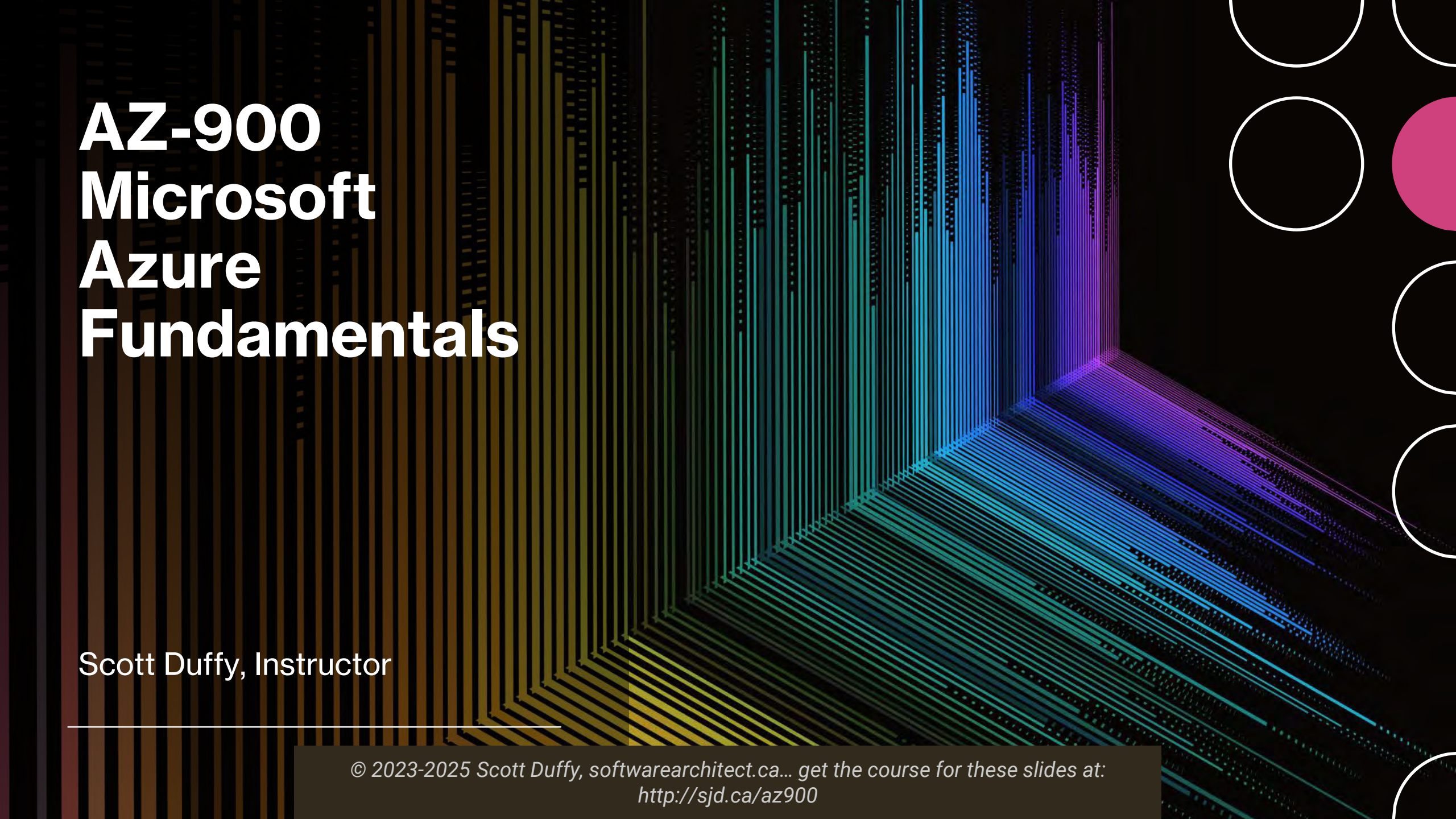

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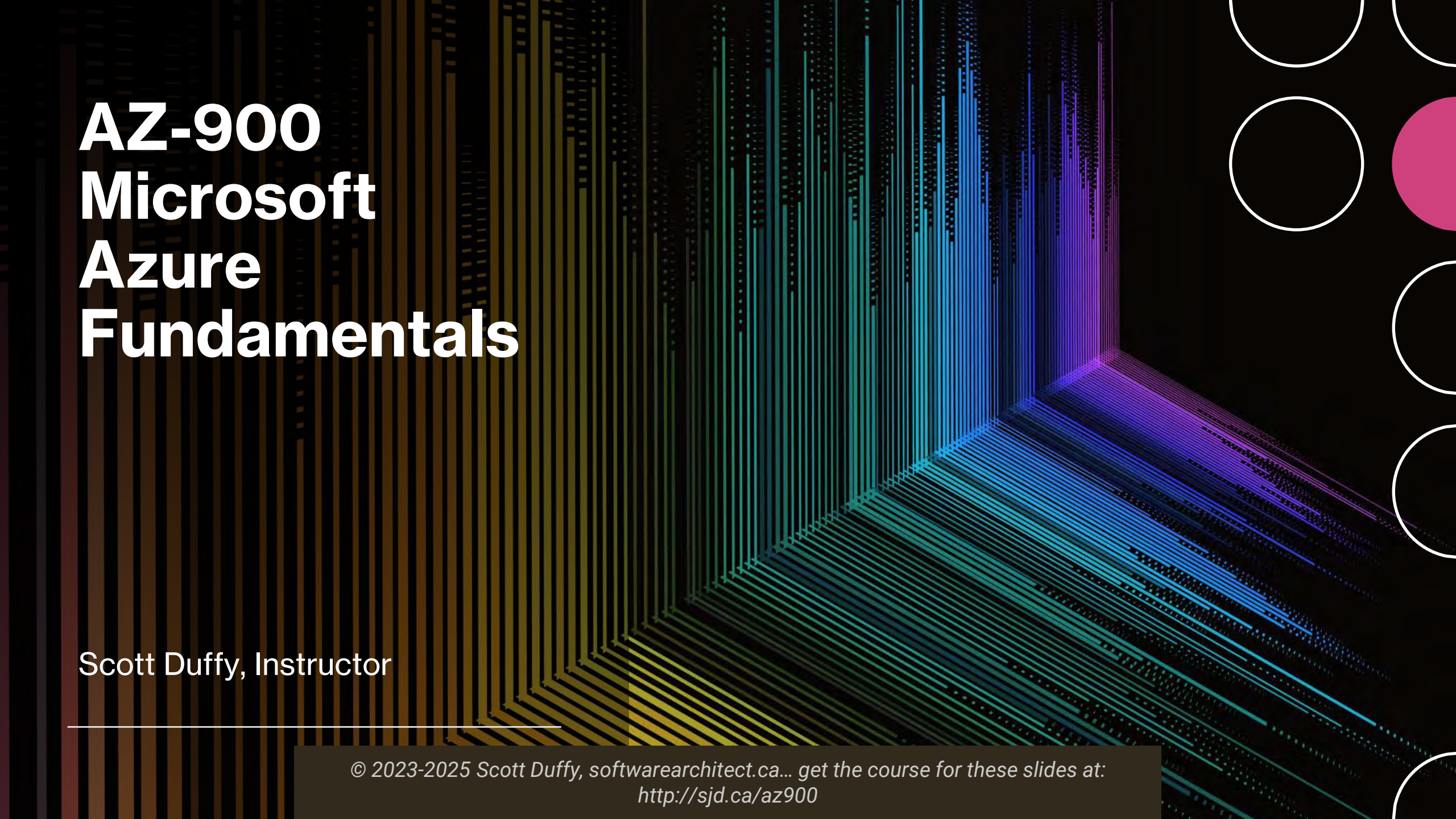

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Azure
File

Azure Files

- True hierarchical structure with folders
- You can “mount” this to a server and use a drive letter with it (i.e. “S: drive”) – Windows, Linux, macOS
- Supports SMB, or NFS (Linux)

Why?

- Replace or supplement your on-prem file
- Lift and shift migration to the cloud
- Adds redundancy, data recovery, failover benefits

Azure File Sync

- Hybrid option – on prem files with cloud option
- Cloud tiering
- Distributed access
- Cloud backup


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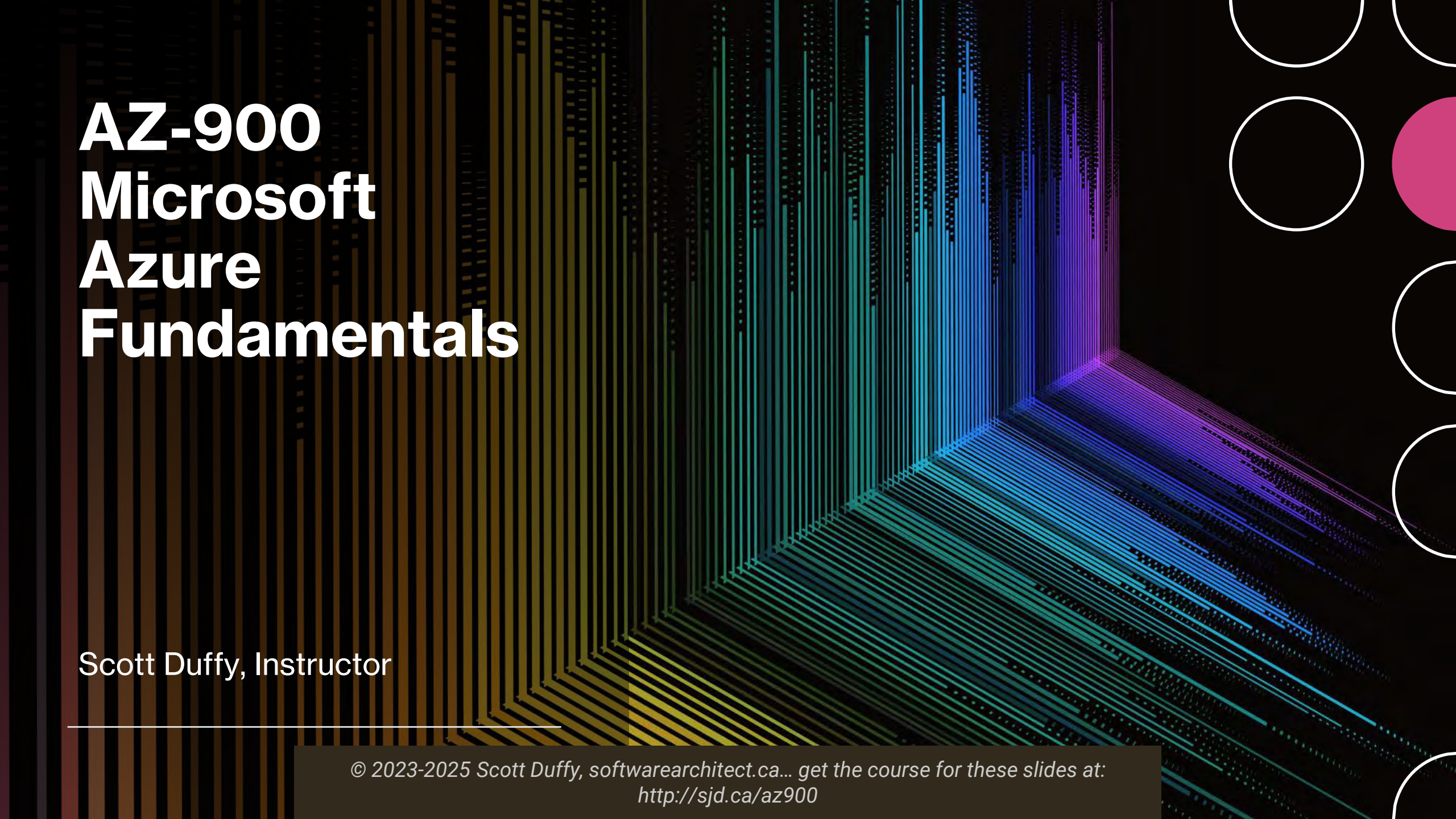

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Azure
Migrate

Guided experience to get your workloads into Azure

Azure Migrate | Get started

Microsoft

Search

Get started
Explore more

Migration goals

Servers, databases and web apps
Databases (only)
VDI
Web apps
Data Box

Manage

Discovered items
Properties

Support + troubleshooting

Diagnose and solve problems
New support request

Migrate and modernize your datacenters

Simplify migration and modernization with a unified platform, or find an expert to help with your migration. Learn more



Servers, databases and web apps

Discover, assess and migrate servers (physical or virtual) from your datacenter or other clouds to Azure.
(Preview) Discover and assess SQL Server from your VMware, Microsoft Hyper-V, and Physical environments as well as IaaS services of other public clouds.
(Preview) Discover and assess IIS web apps at-scale from your VMware environment using integrated experience.

Discover, assess and migrate



Databases (only)

Assess and migrate your on-premises databases to Azure using standalone tools.

Assess and migrate databases



Explore more scenarios

Assess and migrate web apps, migrate data and assess virtual desktop infrastructure (VDI). Find guidance on various migration activites

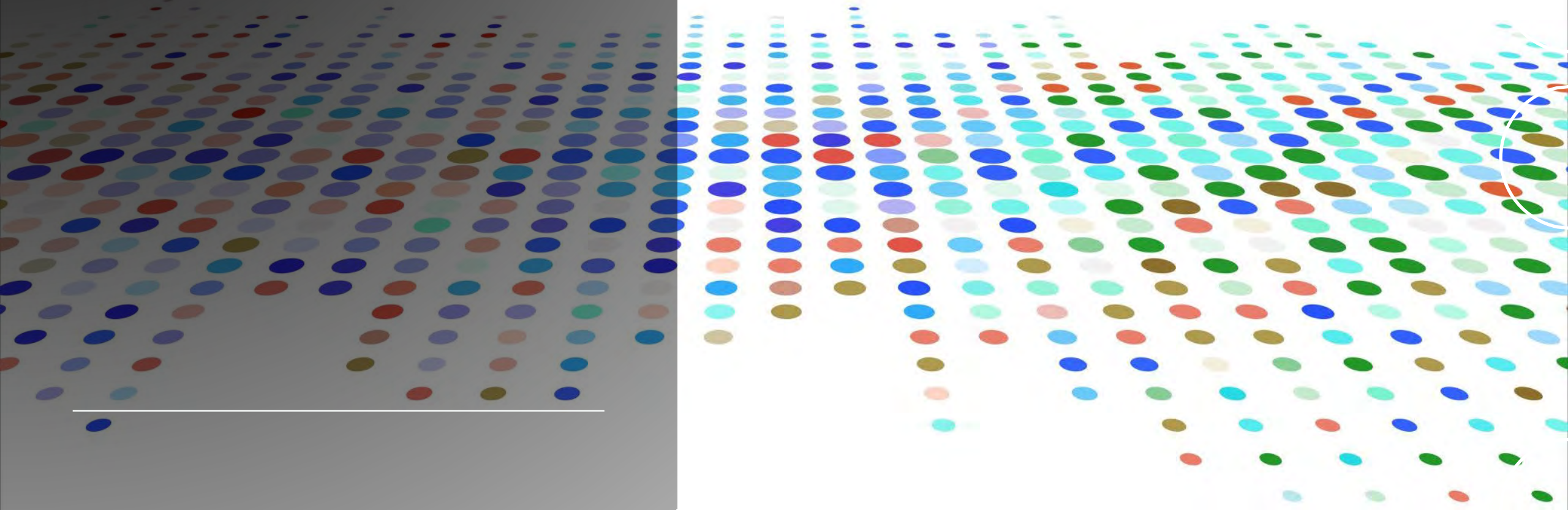
Explore more

A tool to help you discover servers and databases in your environment



Make plans to migrate them into Azure

Which servers can be migrated as-is and which need upgrades

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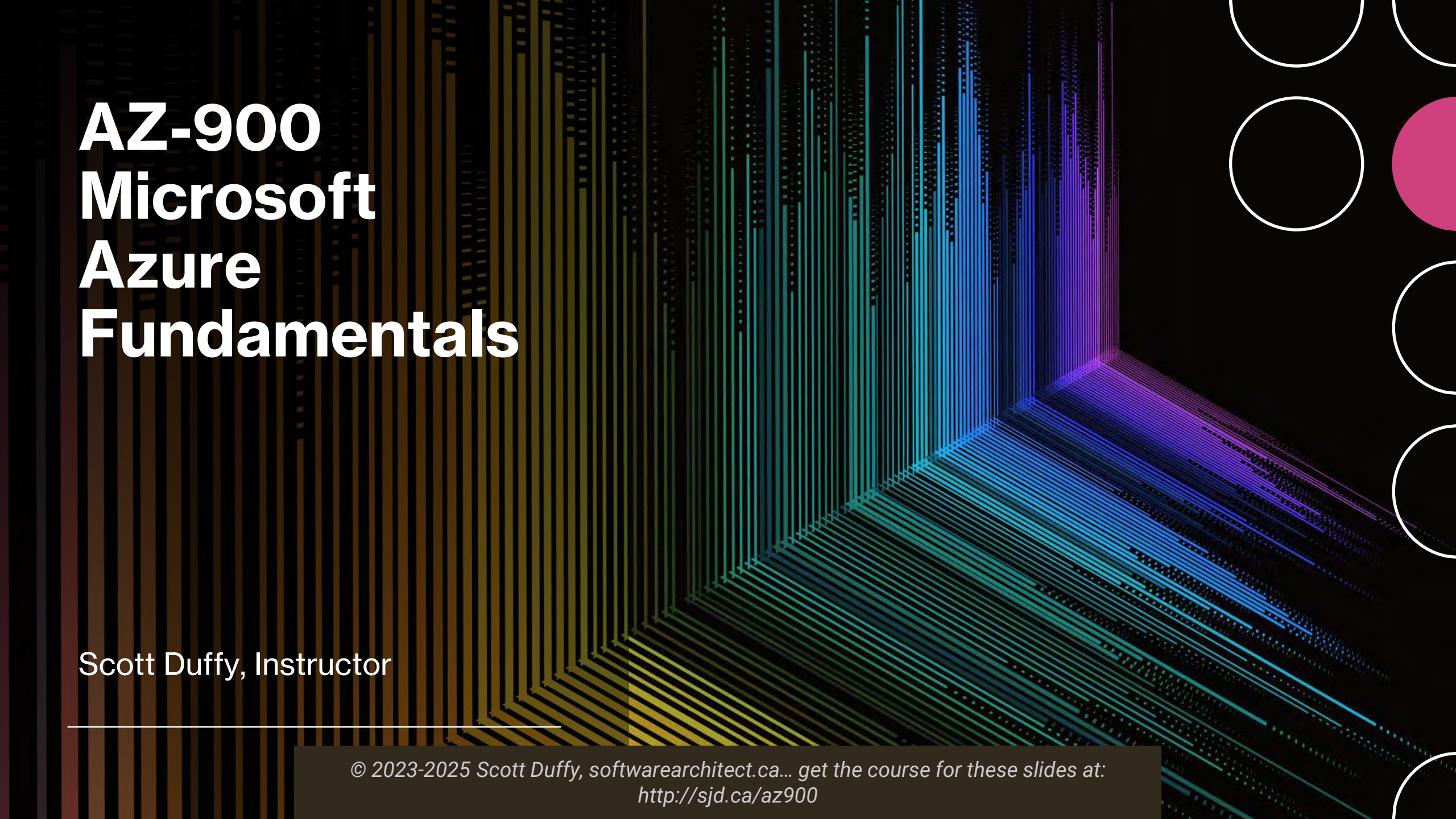

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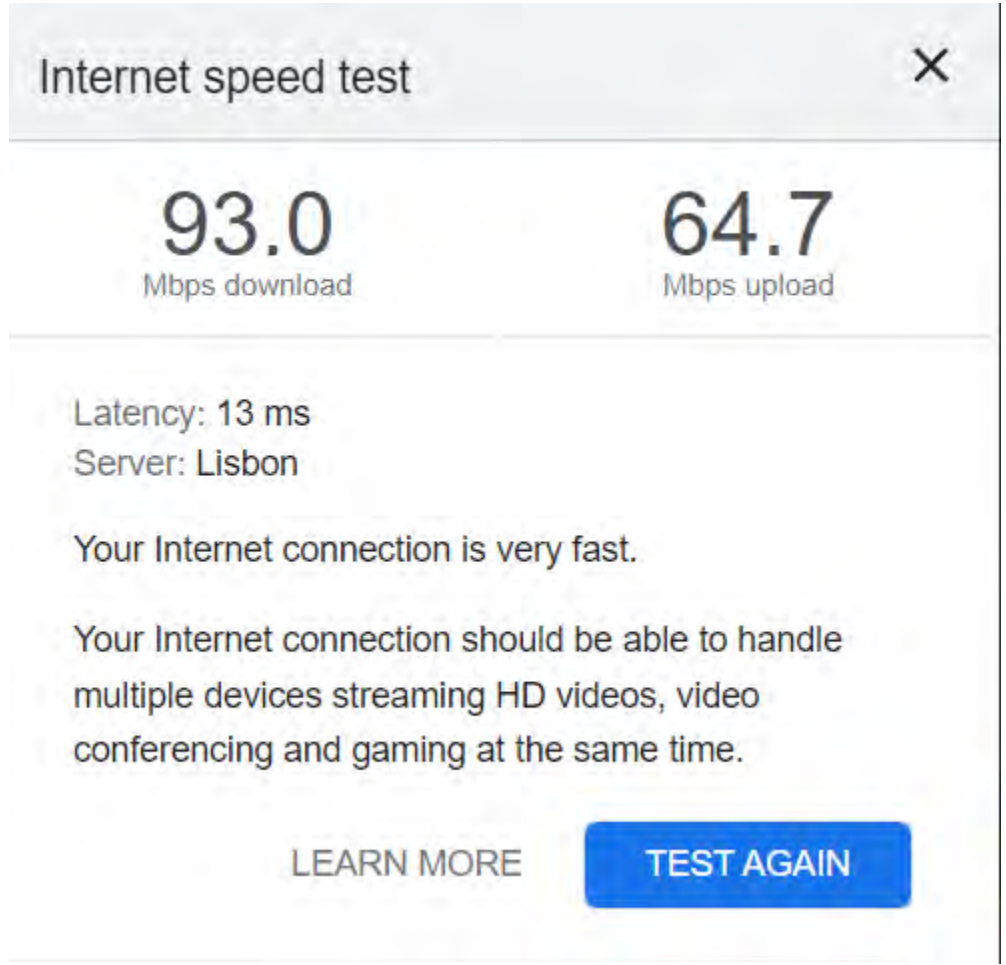
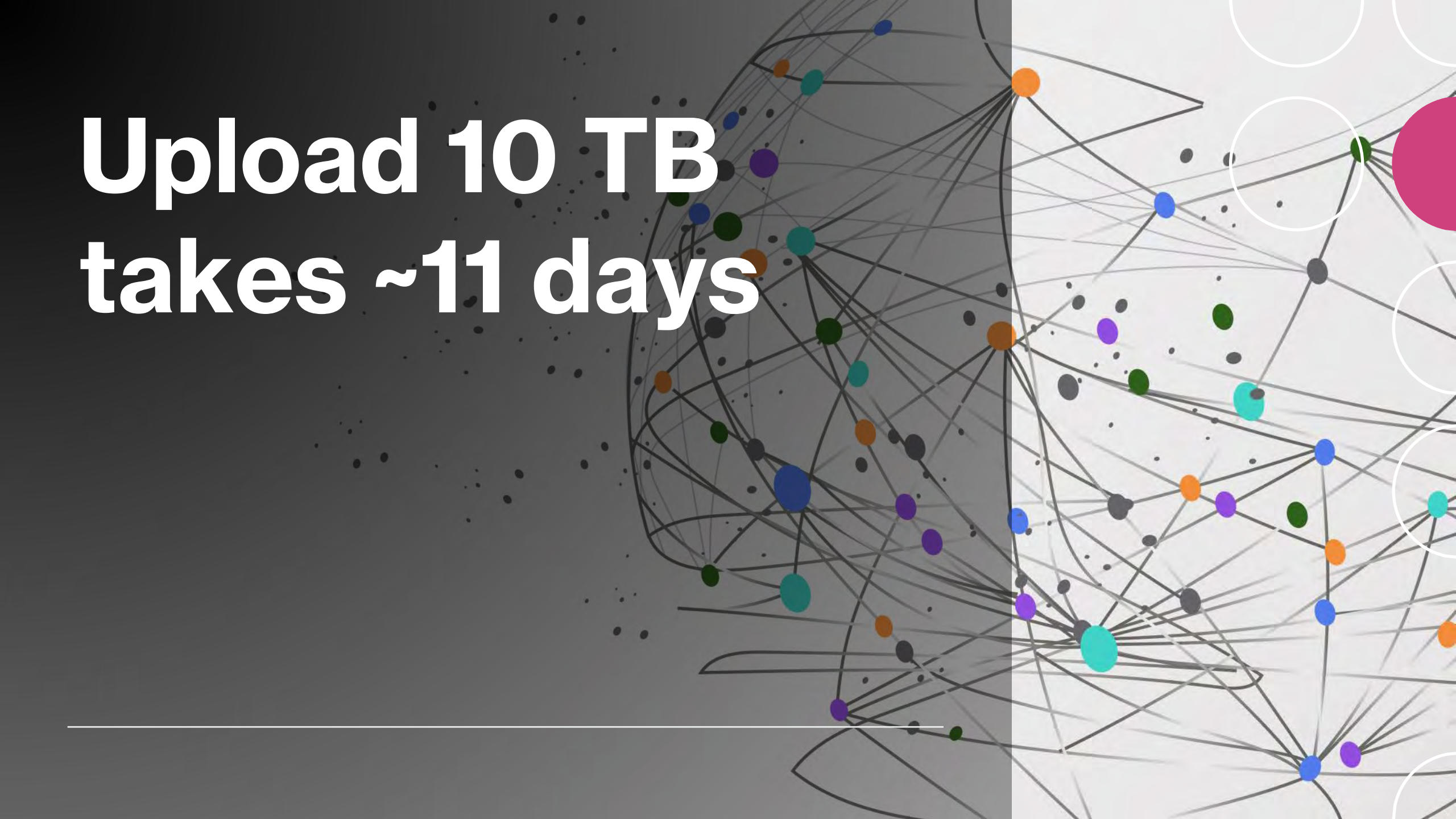
Azure Data Box



It’s impractical to upload some quantities of data


Internet speed test
93.0
Mbps download
64.7
Mbps upload
Latency: 13 ms
Server: Lisbon
Your Internet connection is very fast.
Your Internet connection should be able to handle multiple devices streaming HD videos, video conferencing and gaming at the same time.
LEARN MORE
TEST AGAIN

Upload 10 TB takes ~11 days



Data Box



100 TB

Data Box Disk



8 TB

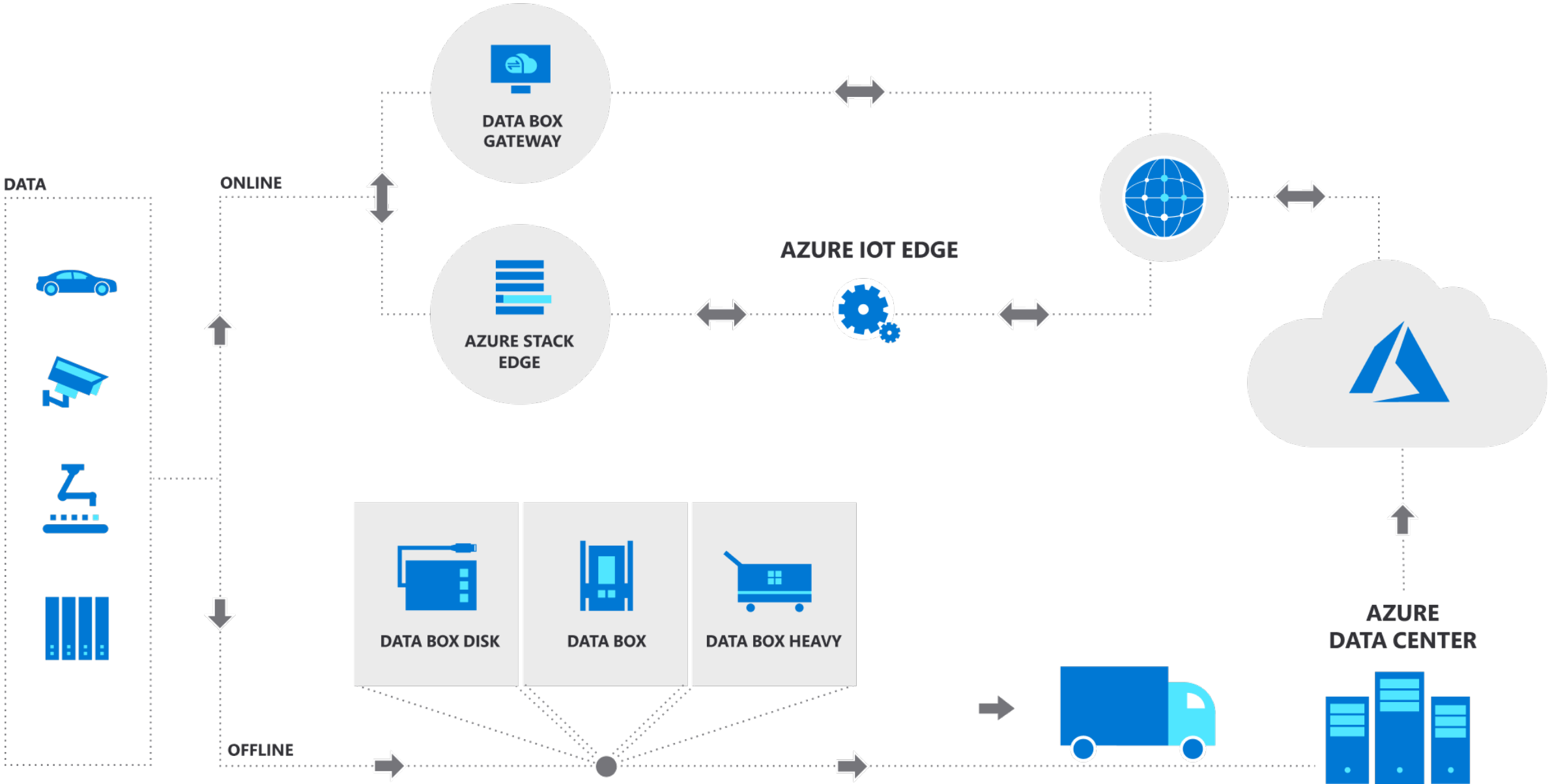
Data Box Heav

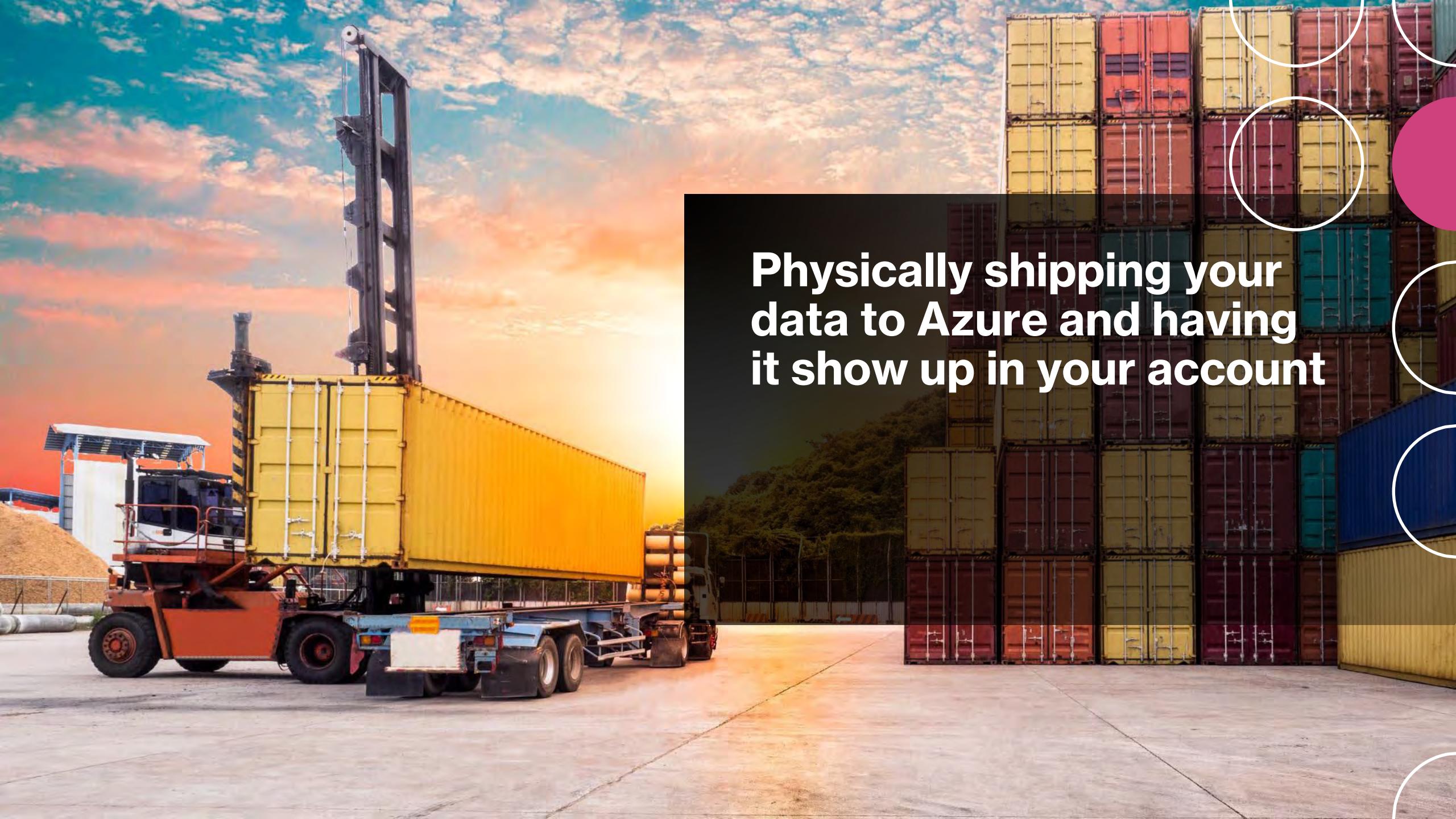


1 PB

Data Box

Get your data to the cloud




Physically shipping your data to Azure and having it show up in your account


Encrypted, wiped-
clean after use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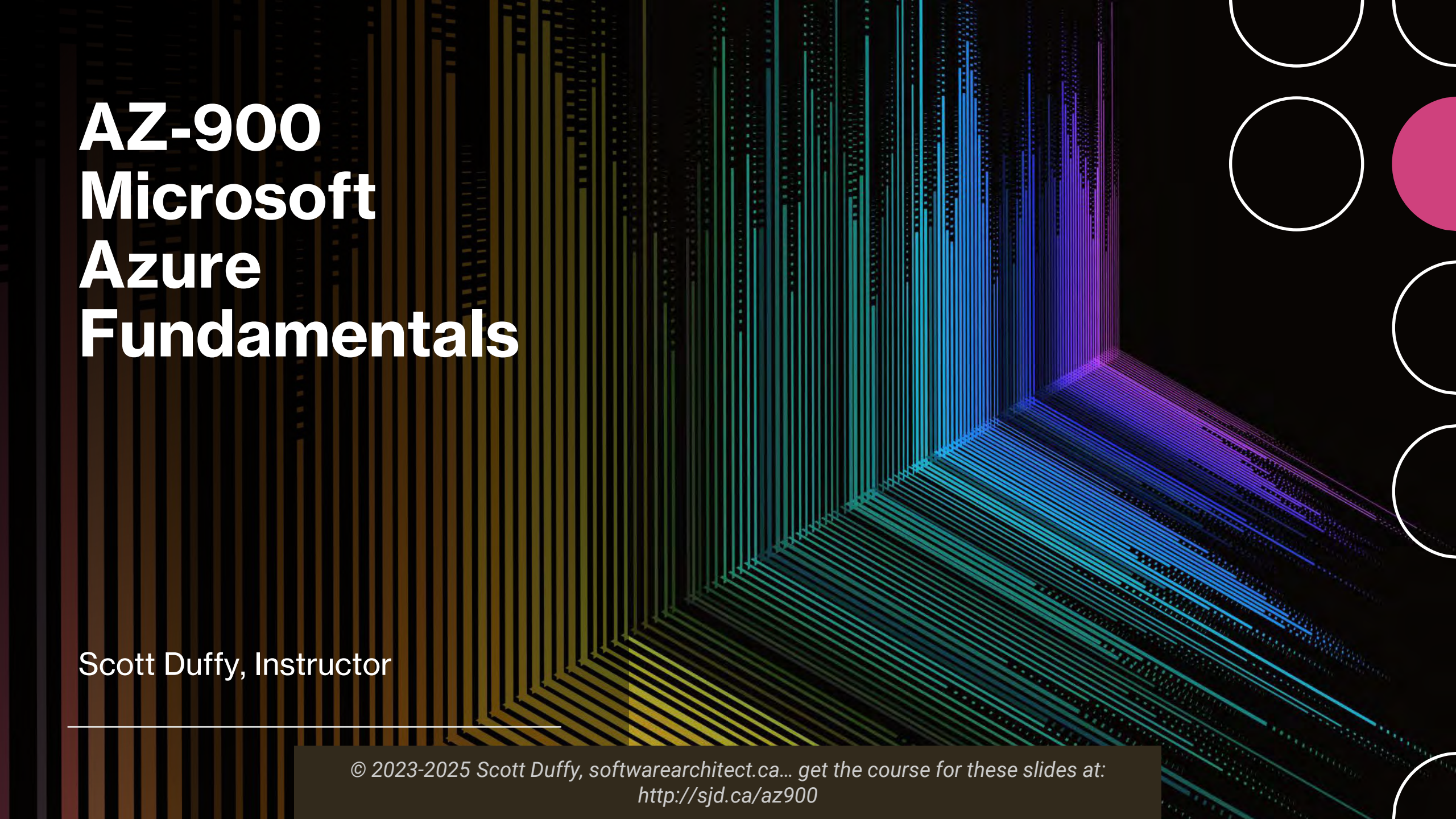

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- Describe virtual networking, including the purpose of Azure virtual networks, Azure virtual subnets, peering, Azure DNS, Azure VPN Gateway, and ExpressRoute
- Define public and private endpoints

Describe Azure storage services

- Compare Azure Storage services
- Describe storage tiers
- Describe redundancy options
- Describe storage account options and storage types
- Identify options for moving files, including AzCopy, Azure Storage Explorer, and Azure File Sync
- Describe migration options, including Azure Migrate and Azure Data Box

Describe Azure identity, access, and security

- Describe directory services in Azure, including Microsoft Entra ID and Microsoft Entra Domain Services
- Describe authentication methods in Azure, including single sign-on (SSO), multi-factor authentication (MFA), and passwordless
- Describe external identities in Azure, including business-to-business (B2B) and business-to-customer (B2C)
- Describe Microsoft Entra Conditional Access
- Describe Azure role-based access control (RBAC)
- Describe the concept of Zero Trust
- Describe the purpose of the defense-in-depth model
- Describe the purpose of Microsoft Defender for Cloud

The concept of Identity



In computing, “identity” is a representation of a person, application or device

Examples of Identity

- John Henry Doe
- johndoe@example.com
- Time Entry Application
- The laser printer on the 6th floor



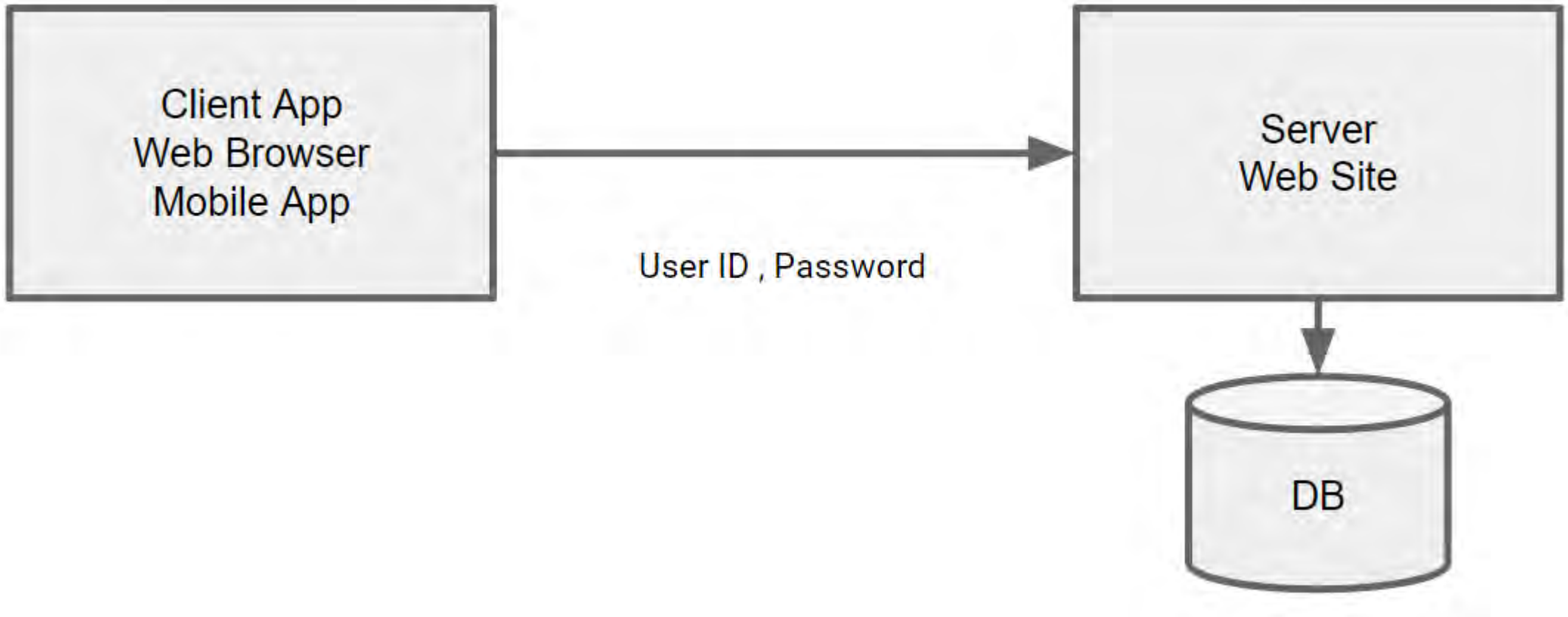
Usually requires a password, a secret key or a certificate to prove



Many applications require you to log in to use some of its functionality

How It’s Traditionally Handled

Client-Server Model

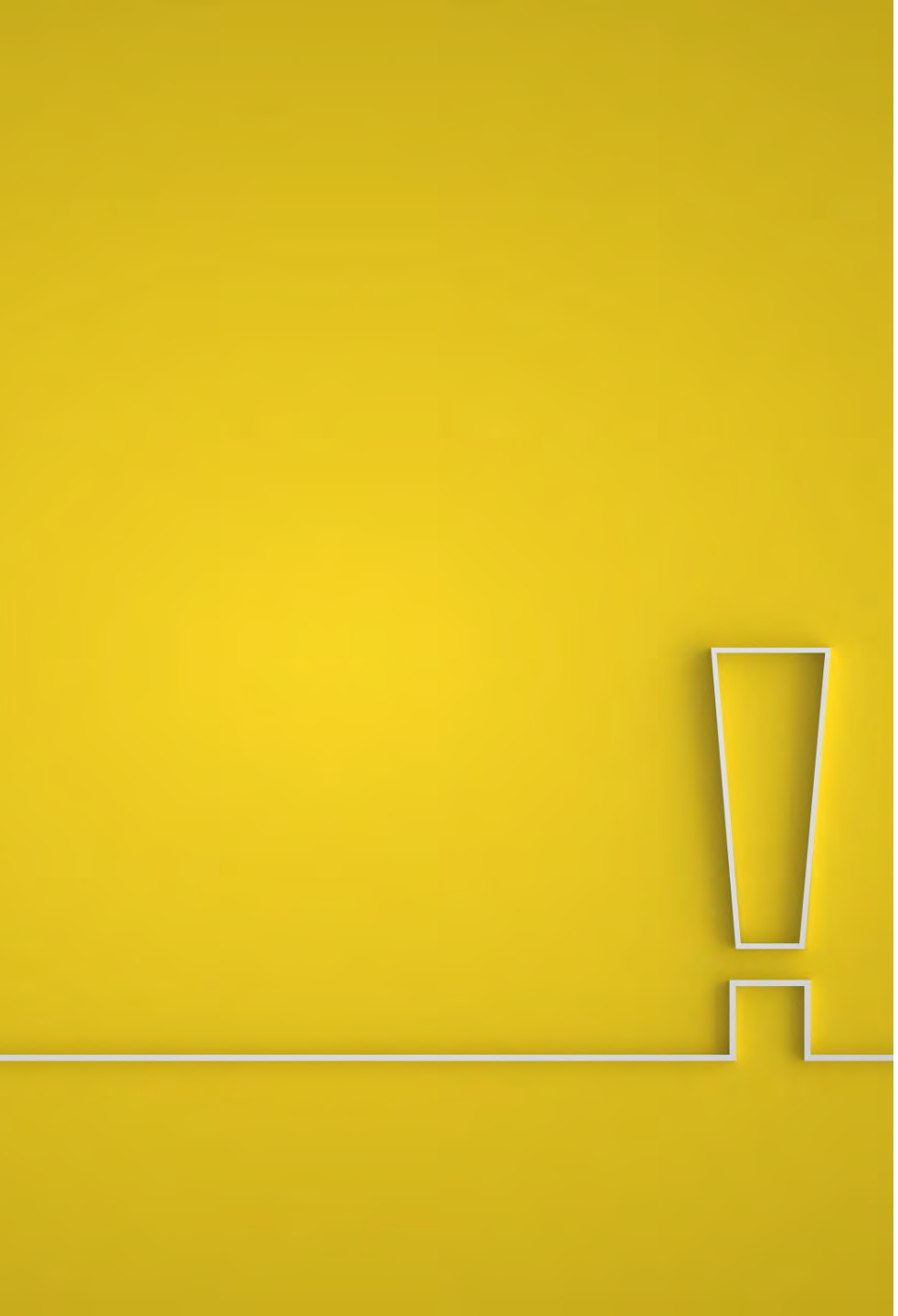




Roll your own code to handle security

Some of the more famous “hacks” have been on custom created identity systems





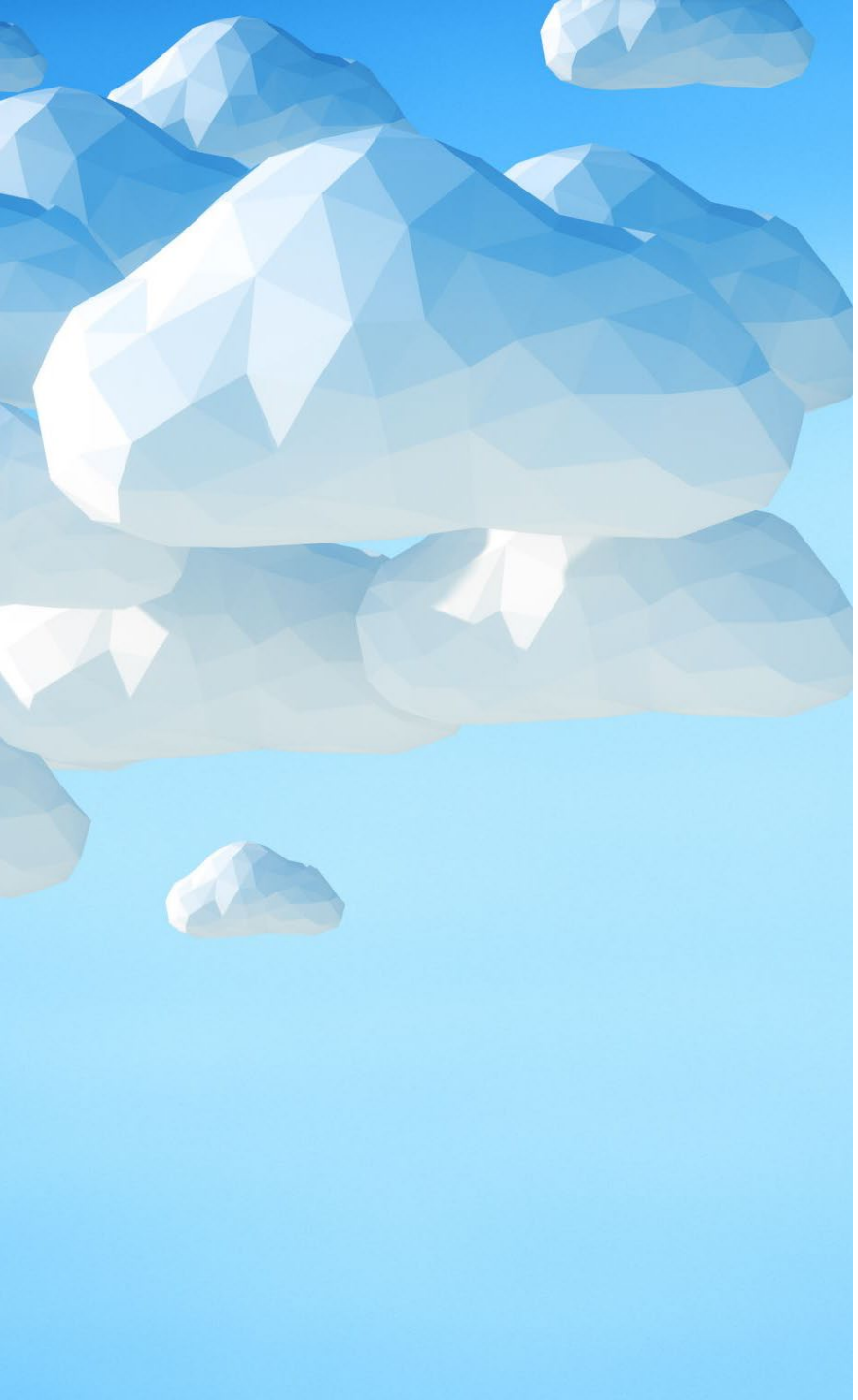
“Identity Systems” Get Hacked All The Time

- Storing password in plain text
- Using outdated (easily broken) hash algorithms like MD5
- Storing the salt with the data
- Not enforcing proper password complexity
- Not enforcing password change policies



Microsoft is a worldwide leader in enterprise identity management with:

Active Directory



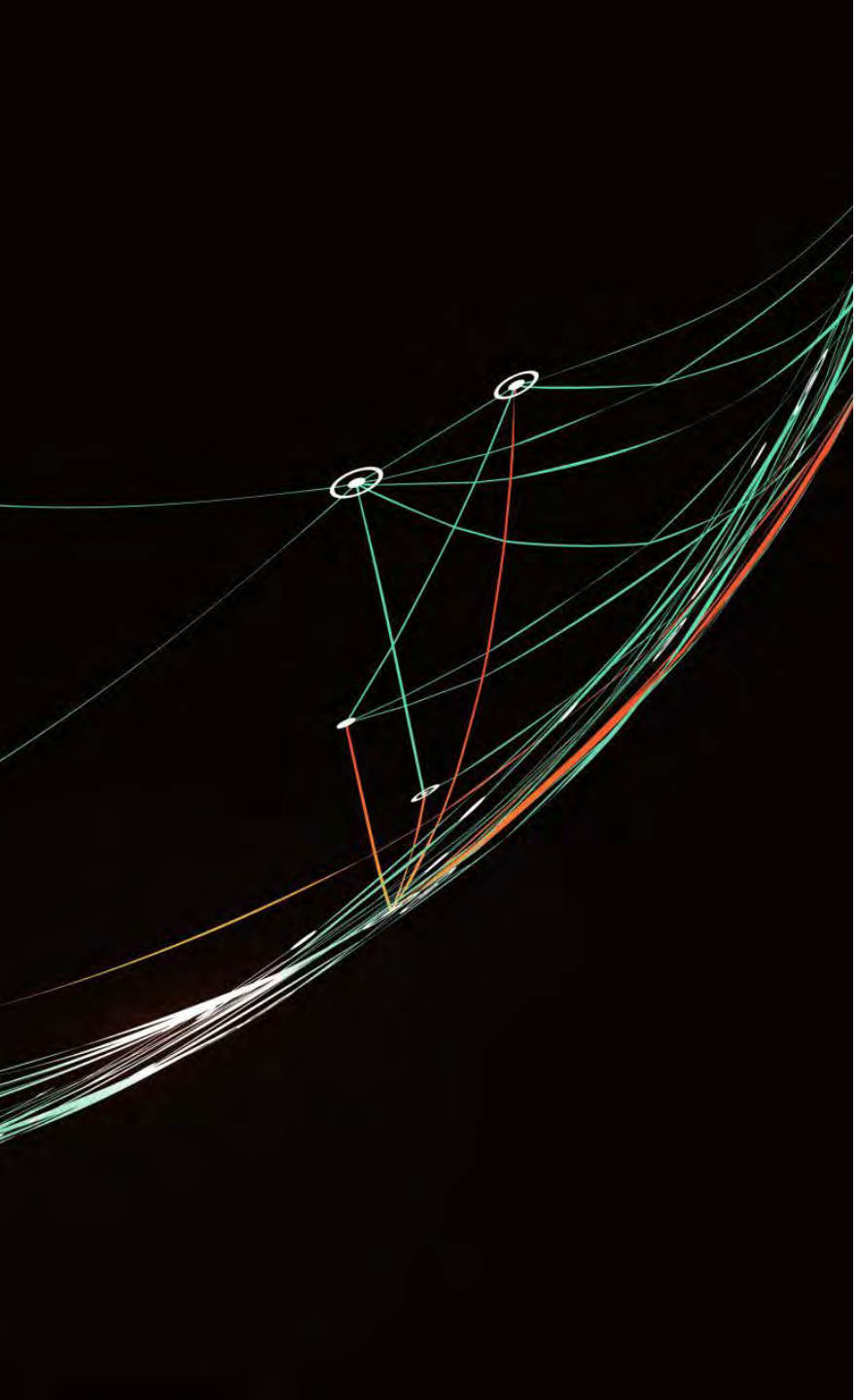
They extend their lead in the cloud with:

Microsoft Entra ID

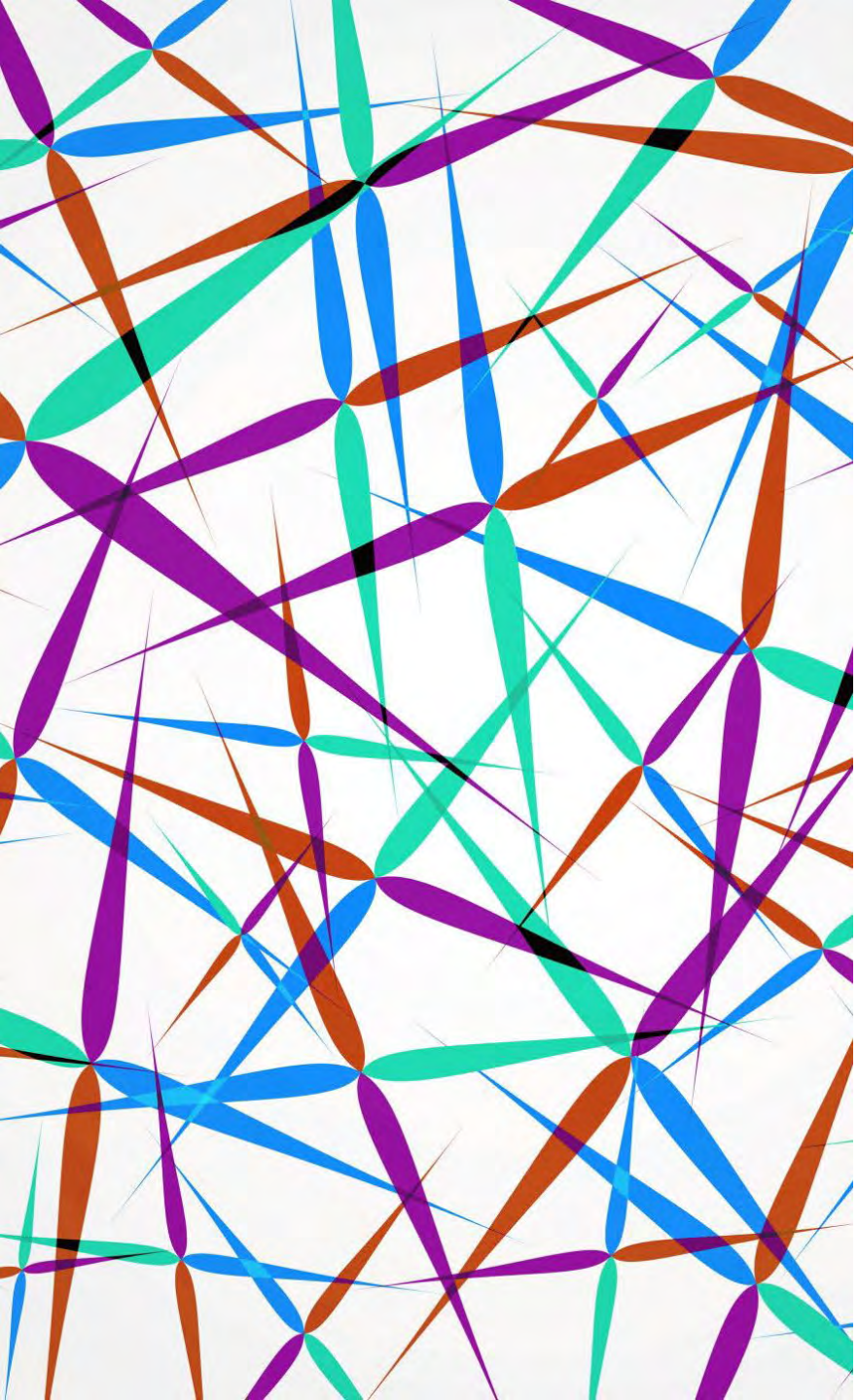


Entra ID used to be known as Azure Active Directory

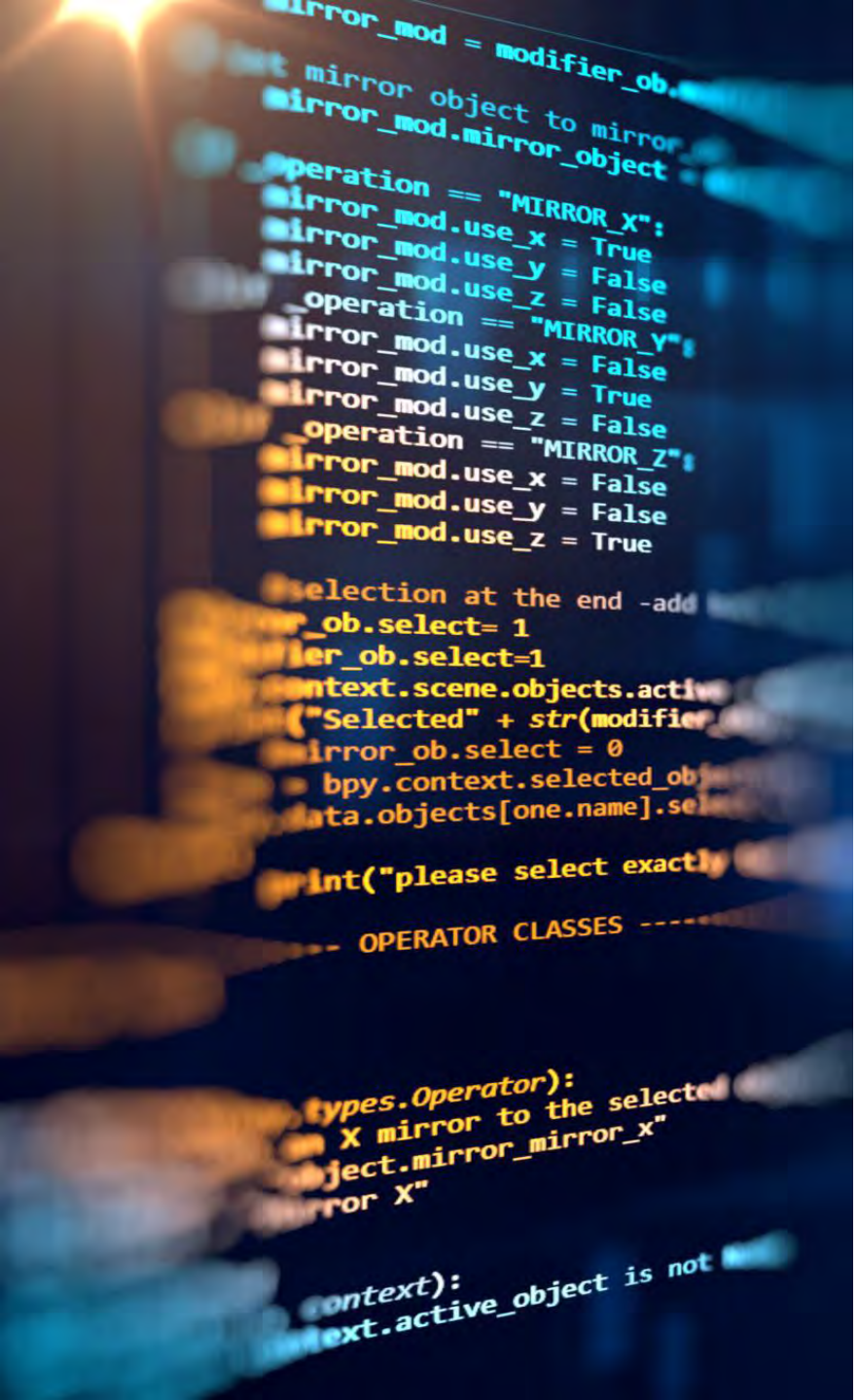
Active Directory and Microsoft Entra are not direct replacements of each other



Active Directory uses protocols such as LDAP and Kerberos for communication

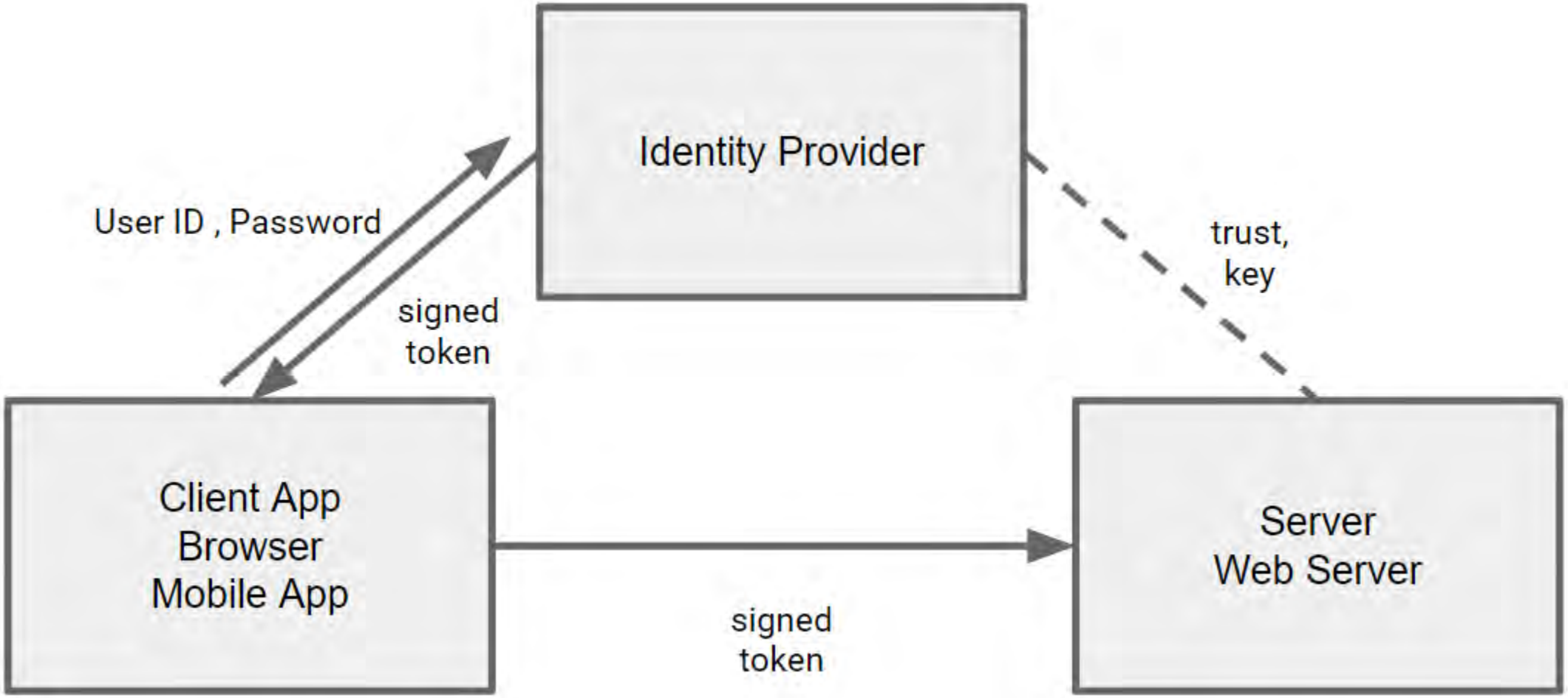


Entra ID uses protocols such as SAML and Oauth for communication



Instead of coding your own security backend, you can use APIs to Entra ID to handle authentication and authorization

Entra ID Model

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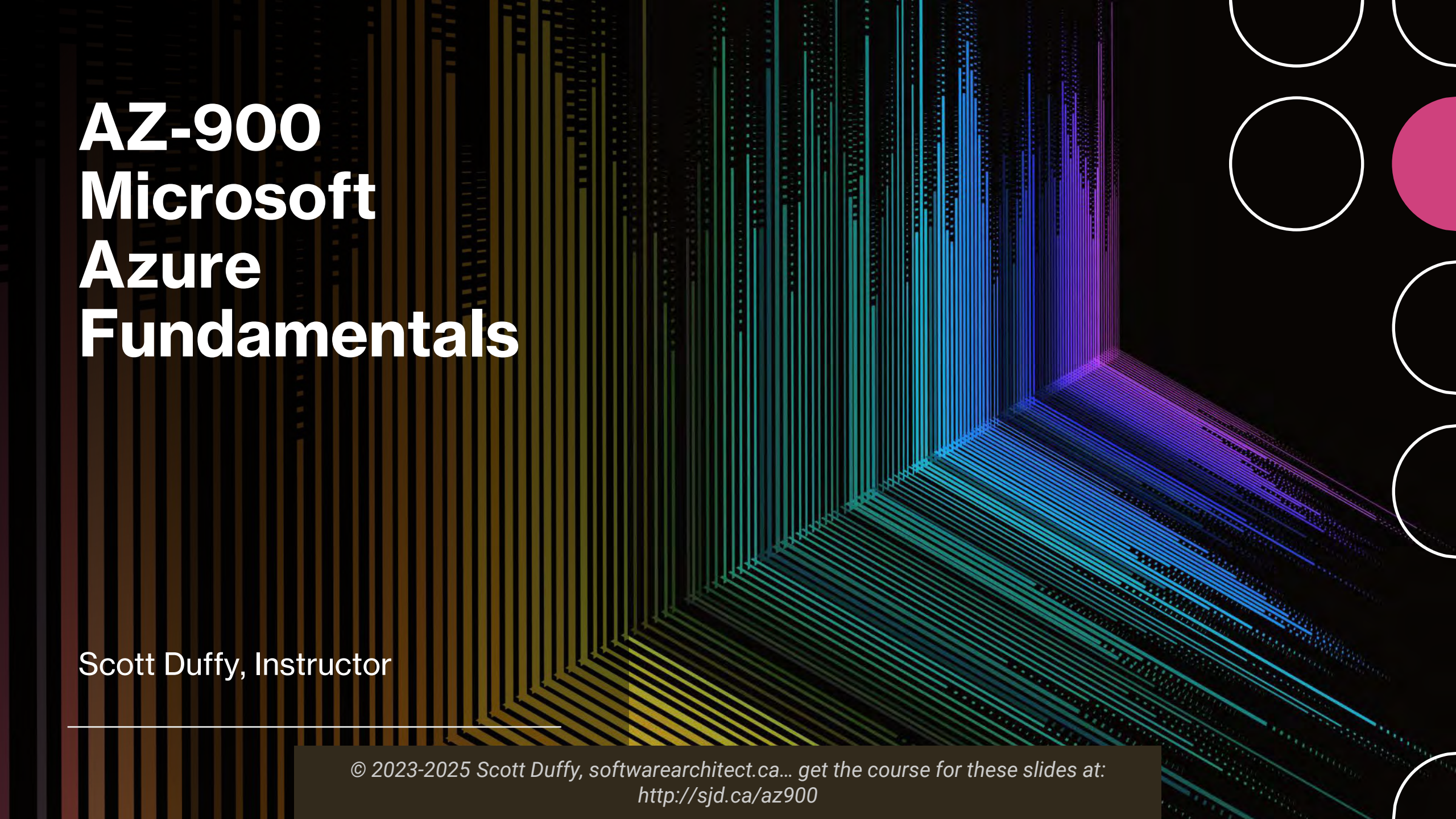

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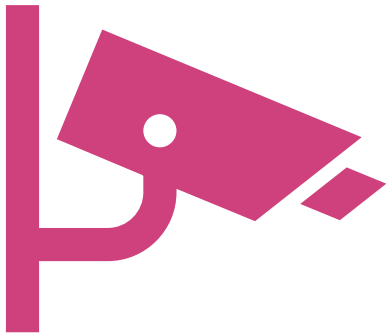
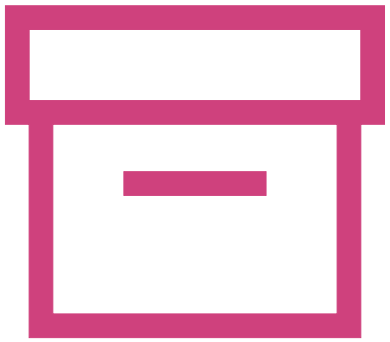


Security

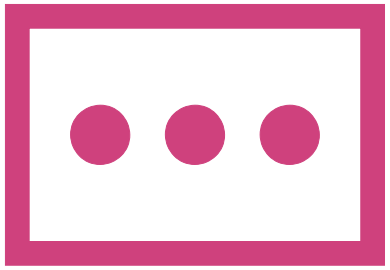


Reduced development time + easier support

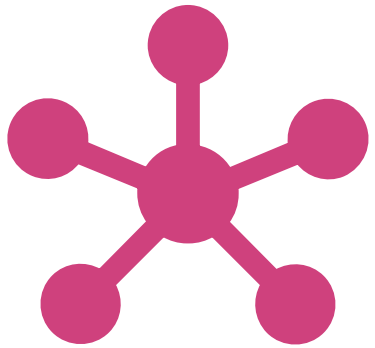
Additional features



Centralized administration



Single sign-on



Integrates with other Azure services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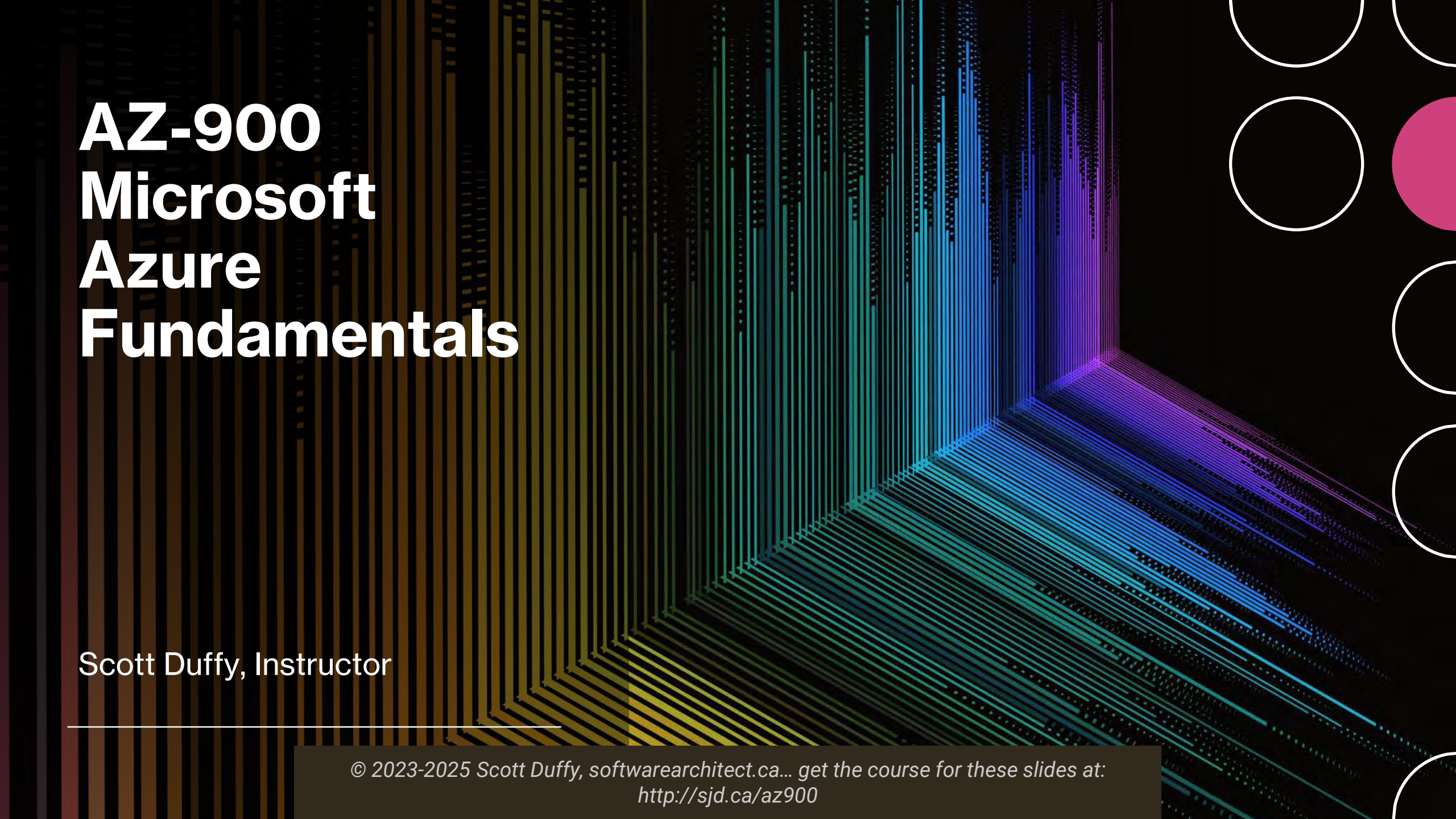

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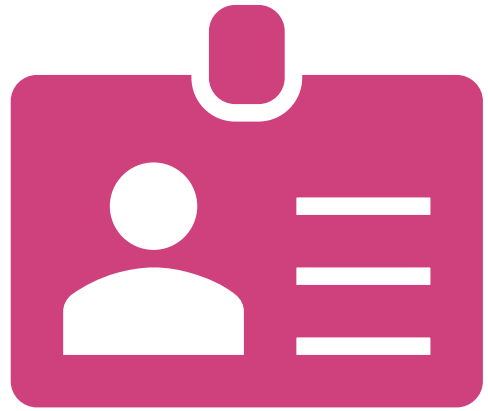
Authentication is a user proving who they are - user id and password



Authorization is ensuring that a user is permitted to perform an action



Move away from all authenticated users having admin access

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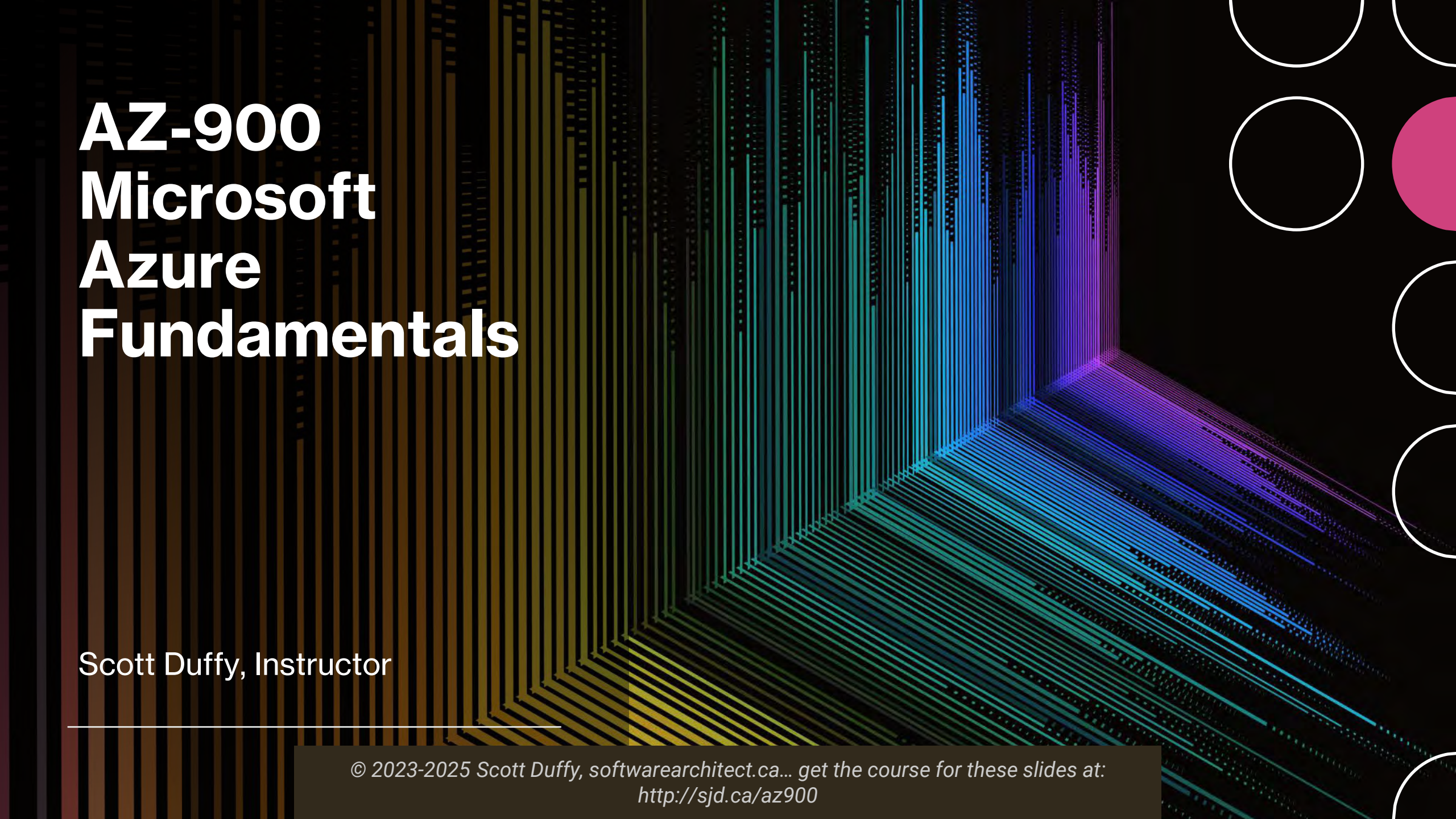

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What are External Identities?

- The ability to give secure access to your resources or applications for people outside of your organization

- Do not need to create or manage a user inside your own corporate Active Directory

Business-to-Business (B2B)

- B2B means inviting partners, contractors or vendors into your organization
- These are guests – Guest Users
- They use their own credentials to log in
- You can assign roles and permissions, same as internal users

Business-to-Consumer (B2C)

- B2C means inviting customers/end users to use your applications
- They do not appear in your organization at all
- Users use “social identities” to sign in like Facebook, Google, LinkedIn, or Microsoft

B2B vs B2C

- B2B is collaboration between businesses, with guest access to your tenant

- B2C is for applications for consumers

Security Benefits

- **Single Sign-on (SSO)** – no need to manage another password
- **Multi-Factor Authentication (MFA)** for stronger security
- You can use Entra ID features such as conditional access


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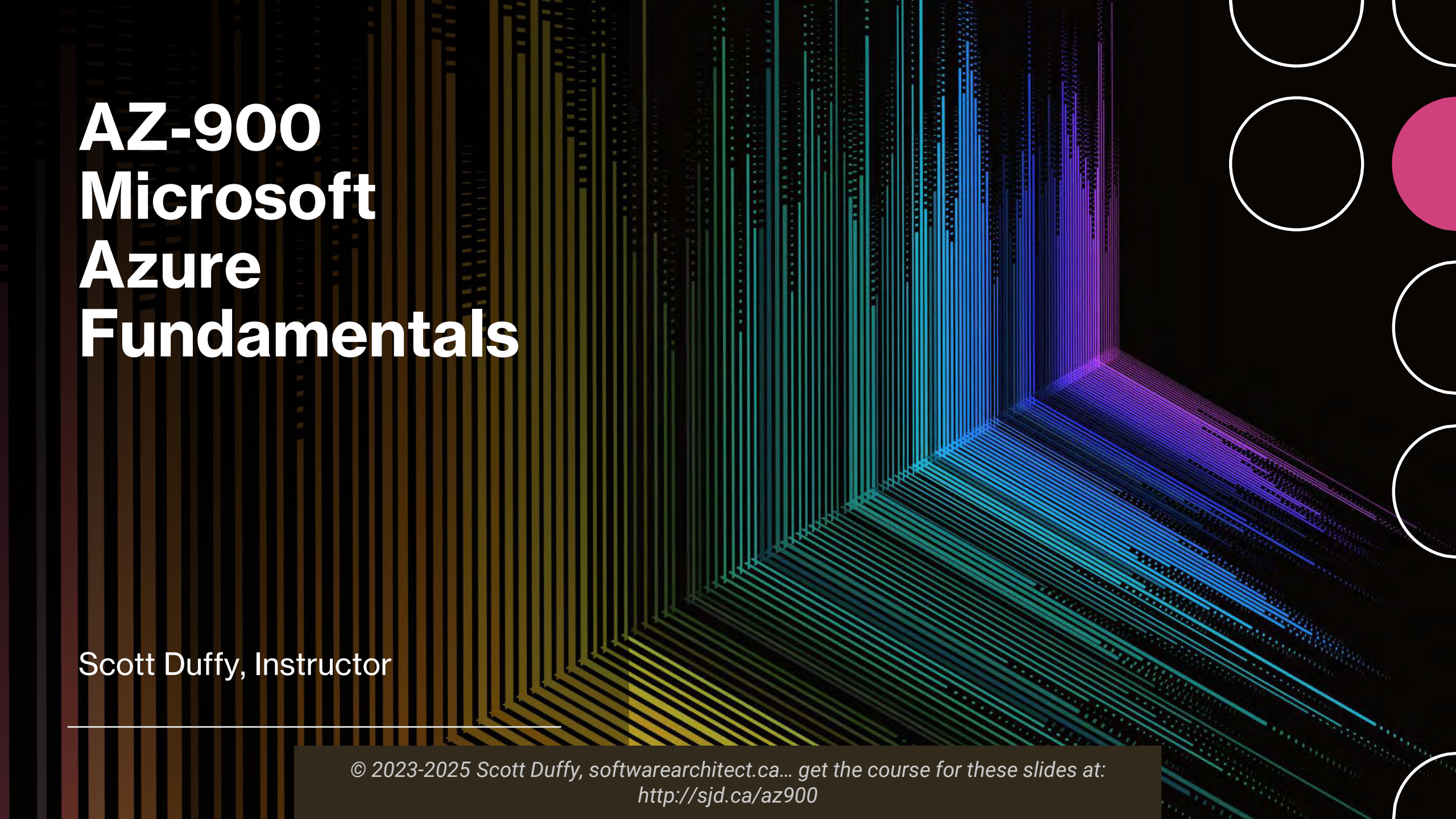

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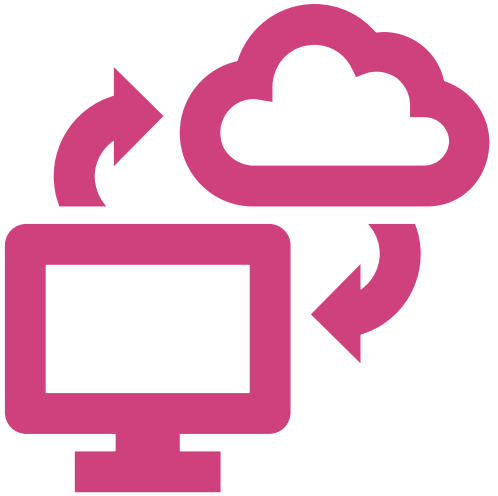
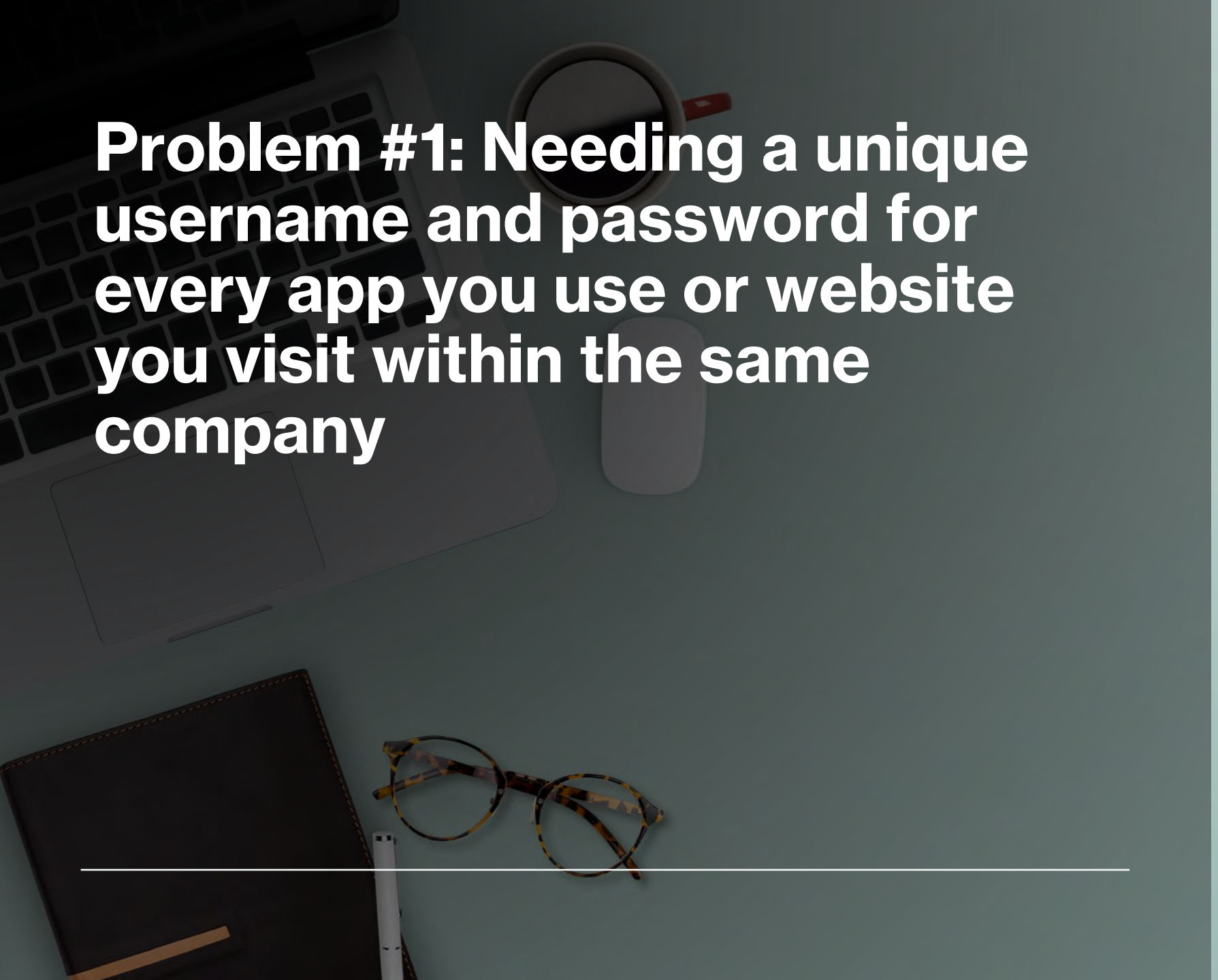
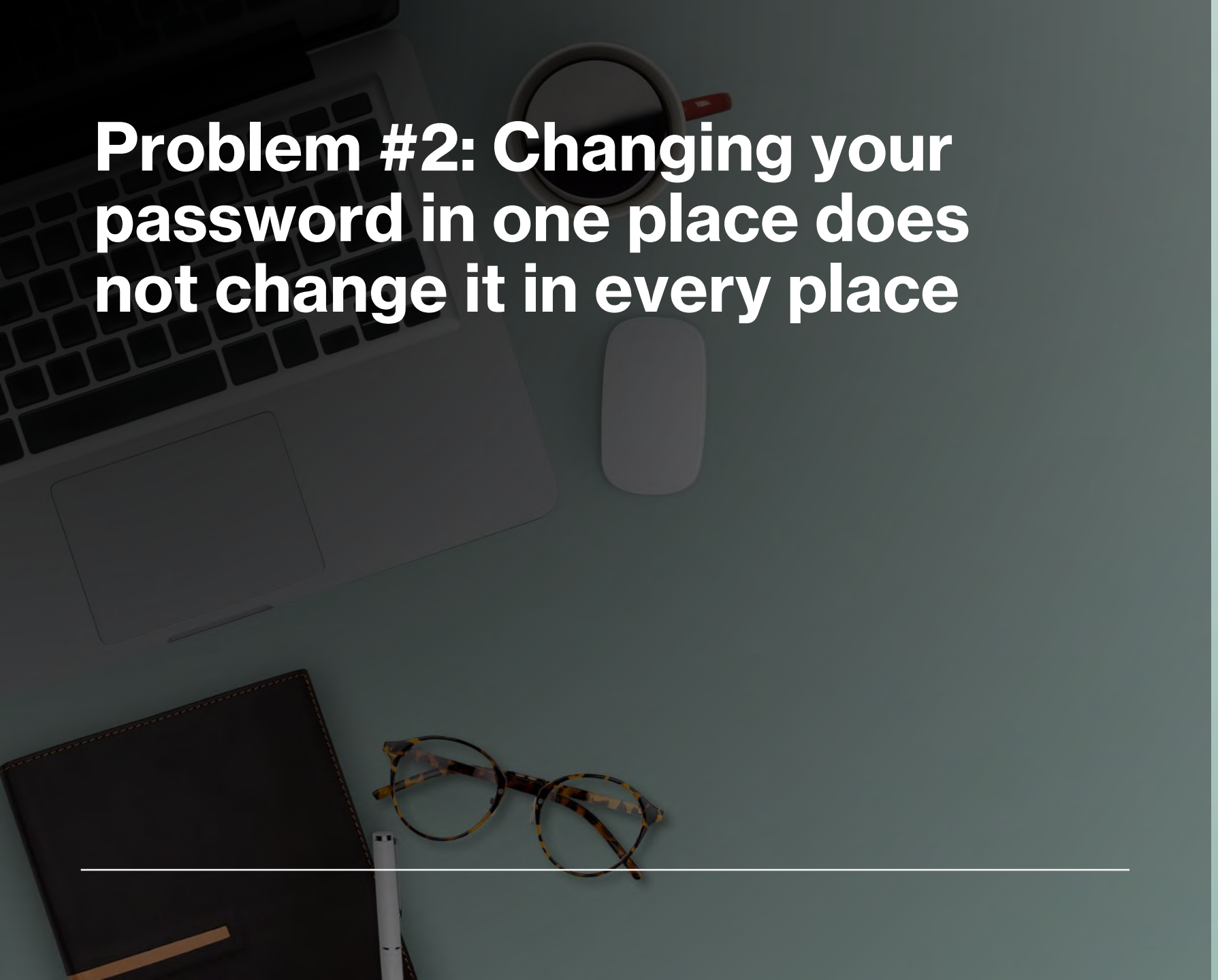
Imagine your company has 10 apps for various things such as time entry, file , design software, etc.



Problem #1: Needing a unique username and password for every app you use or website you visit within the same company



Problem #2: Changing your password in one place does not change it in every place



Potential Solution: Single Sign-On (SSO)

Feature of Entra ID

- Entra ID issues a token that proves who you are
- That token is trusted by all other applications in your company
- Instead of asking for your password again, it checks your token
- Authenticate once, trusted everywhere

How Does it Work?

- The app is registered with your Entra ID
- The app trusts your Entra ID
- The token was encrypted by your Entra ID (private key), and can only be decrypted because of your public key

Benefits of SSO

- For users:
  - Fewer logins
  - Strong passwords / MFA are less tiresome

Benefits of SSO

- For organization:
  - Better security
  - Integrates with MFA / Conditional Access
  - Simplified management

Who Can Use It

- Microsoft Apps
- Your own apps
- Third-party apps like Zoom and Dropbox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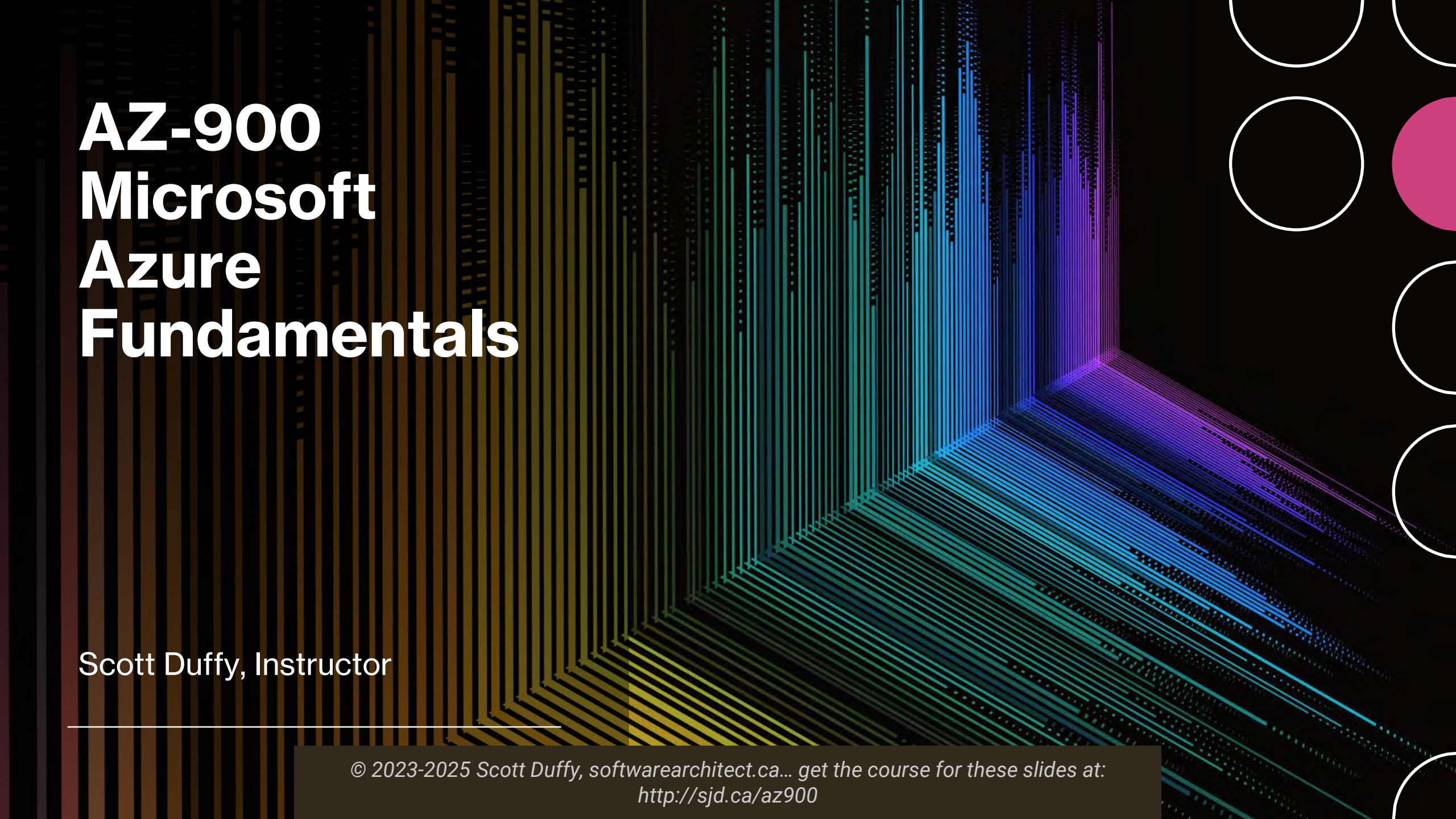

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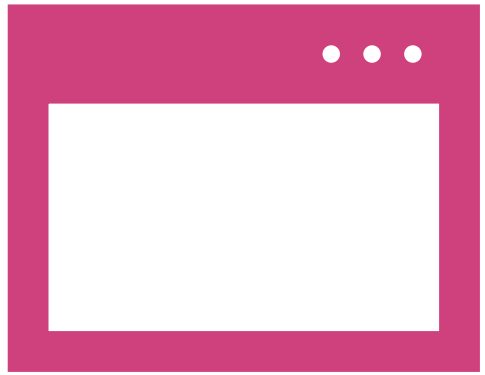
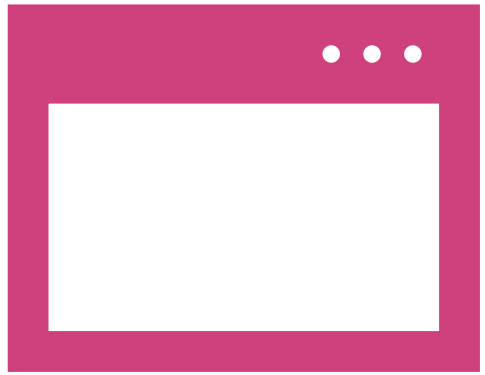
Not all attempts to log into a system are equally safe



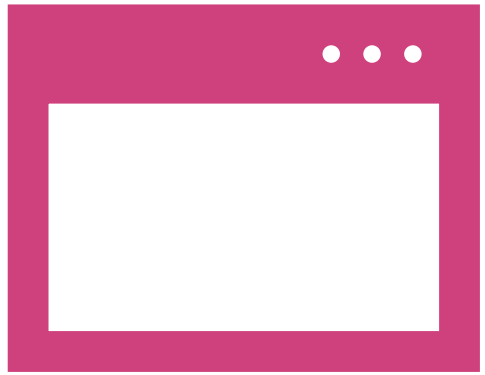
When someone logs in to an application from inside your office building as they do every day...



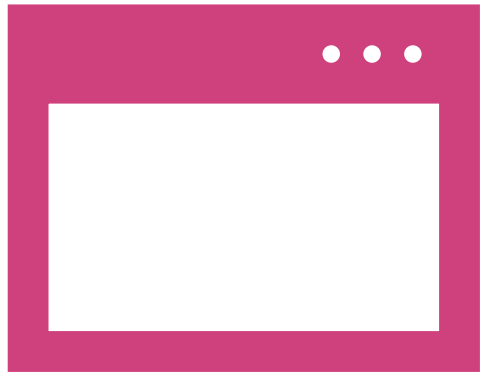
When someone logs in to an application from a country they’re not known to work from...



When someone who hasn’t logged in for months logs in...

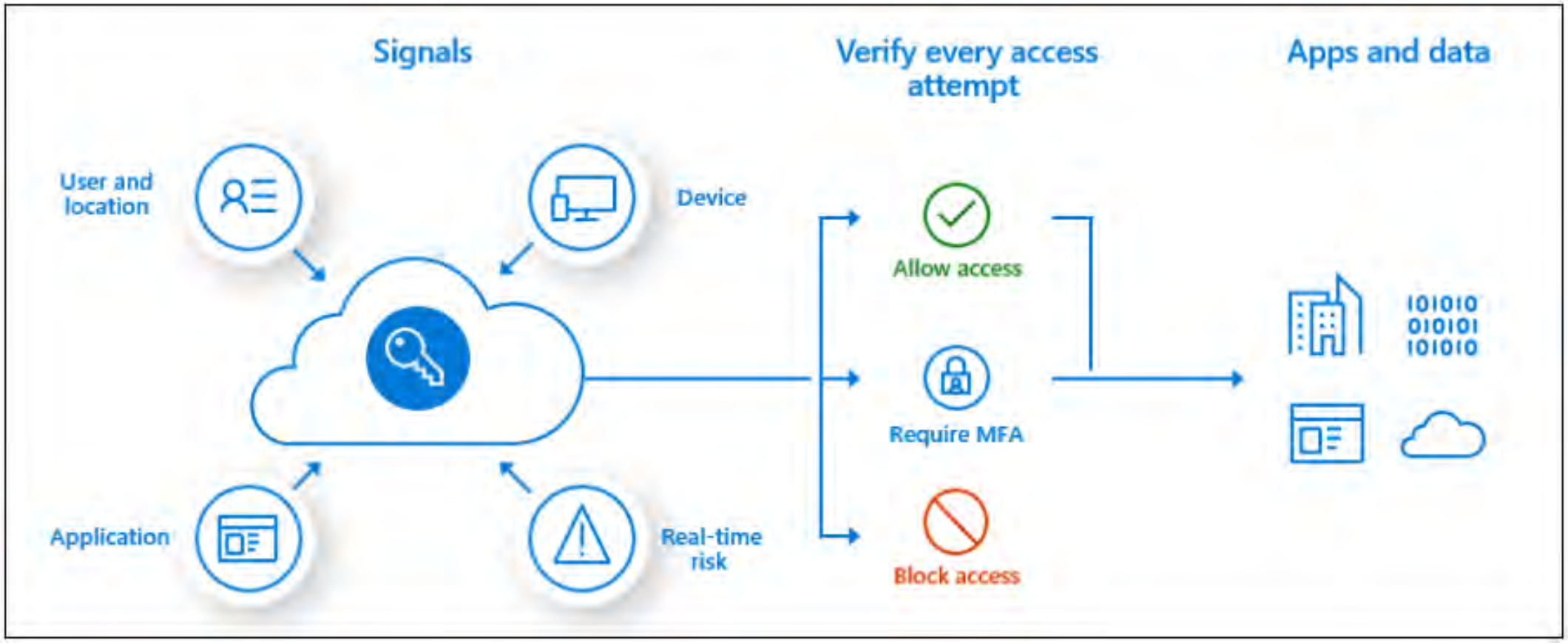


When someone logs in from a device they've never used before...



Not all attempts to log into a system are equally safe




Signals
Verify every access attempt
Apps and data
User and location
Device
Application
Real-time risk
Allow access
Require MFA
Block access
101010
010101
101010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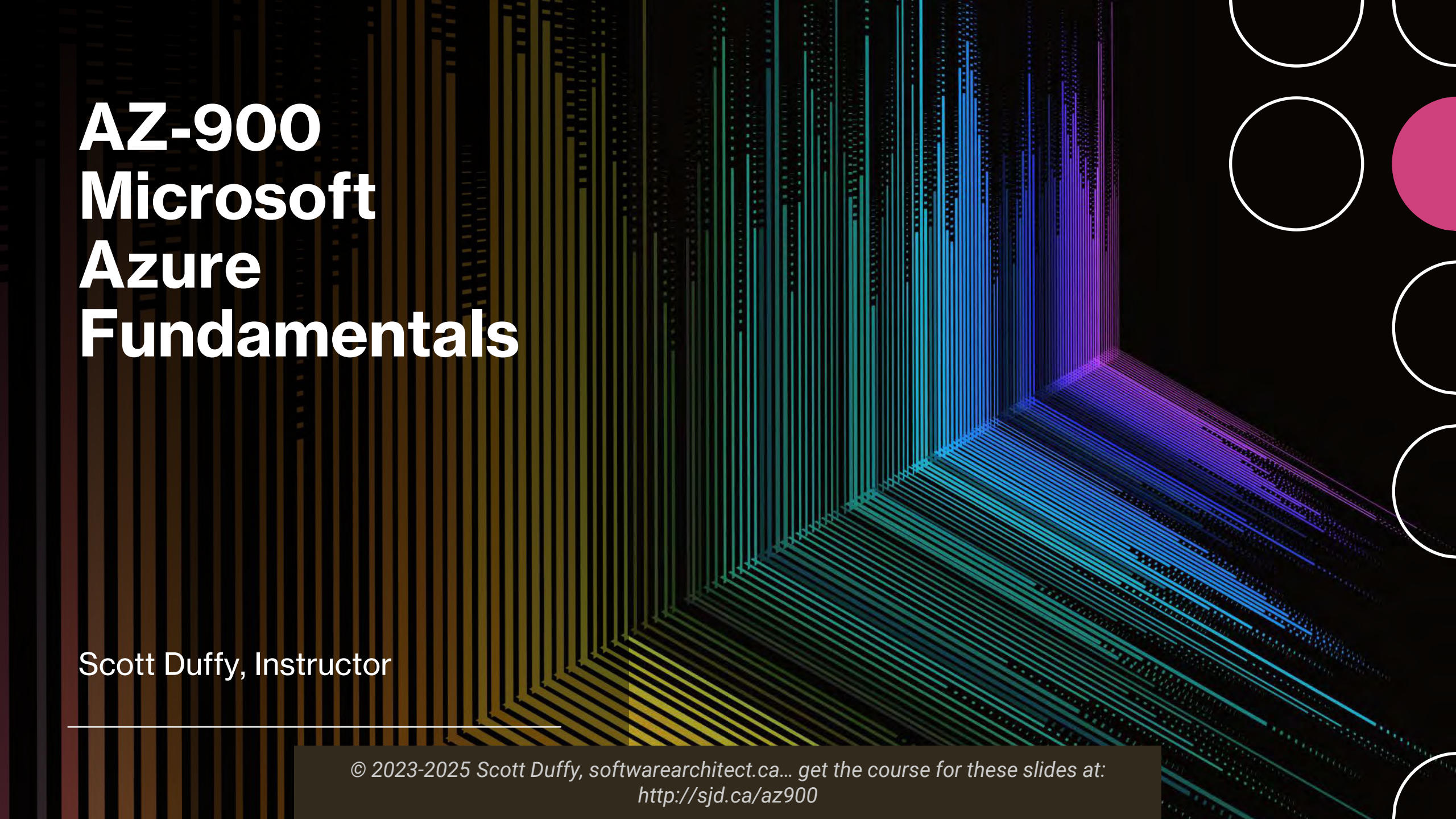

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Require 2 or more pieces of evidence (factors) in order to log in





What Are Factors?

- Something you **know**
- Something you **have**
- Something you **are**

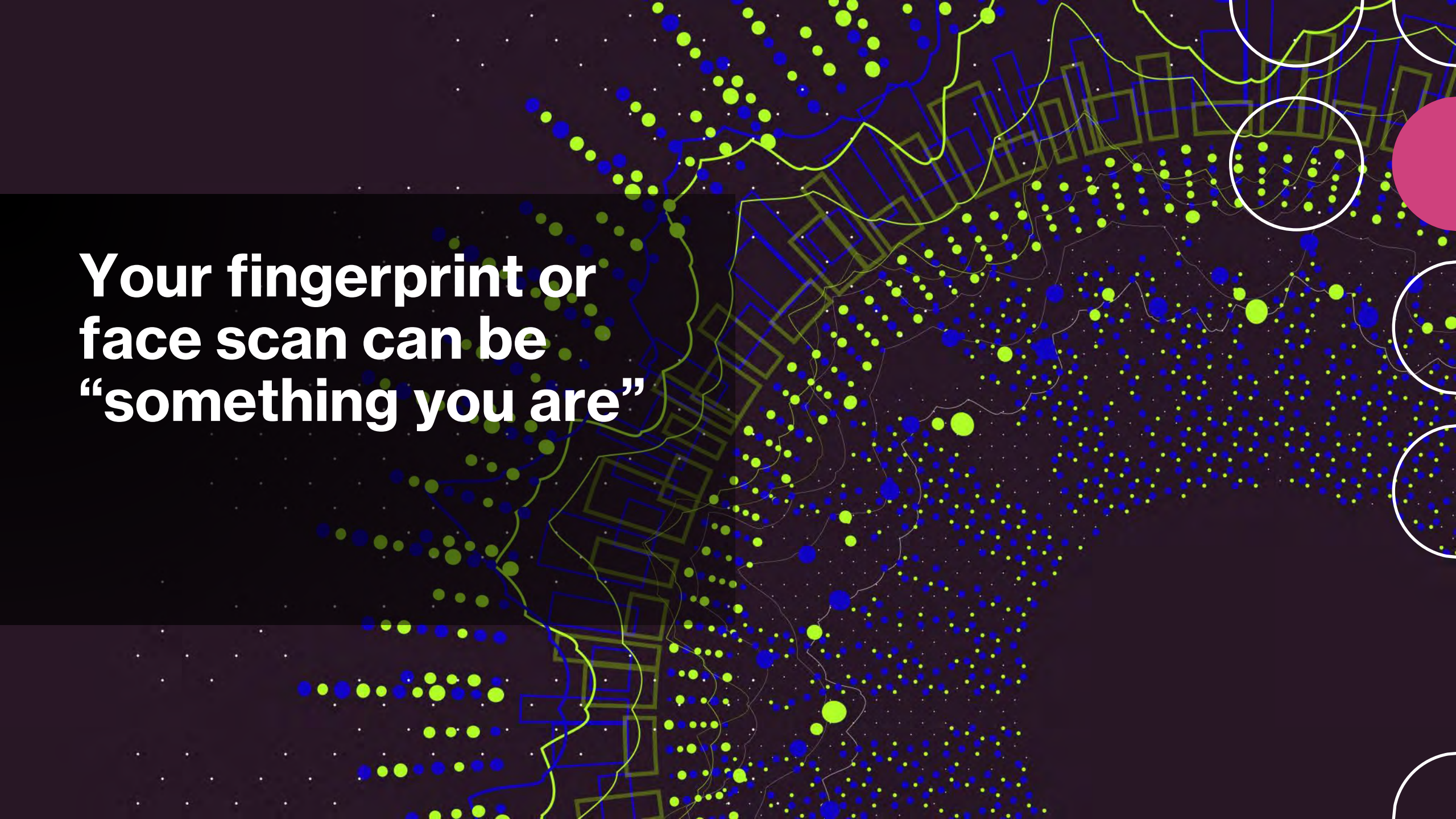
Username is not a factor as it can be public information like email address

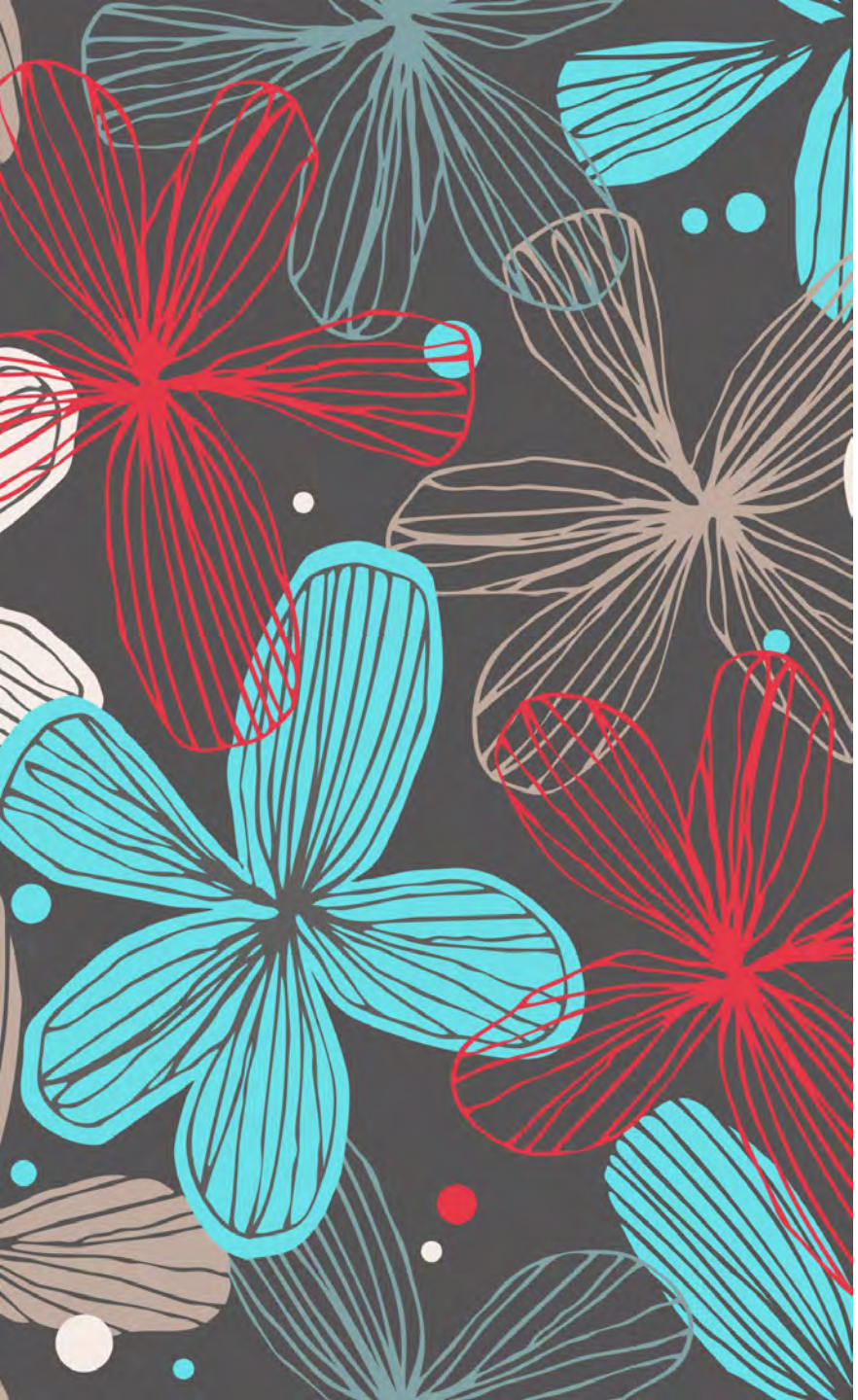




Password is “something you know”, if kept private

Your mobile phone could be “something you have” – SMS, authentication app


Your fingerprint or face scan can be “something you are”



Entra ID Global Administrator accounts can be configured to use MFA for free

Available Methods



Microsoft Authenticator App



Authenticator Lite (in Outlook)



Windows Hello for Business



FIDO2 security key



OATH hardware token (in preview)



OATH software token



SMS



Voice call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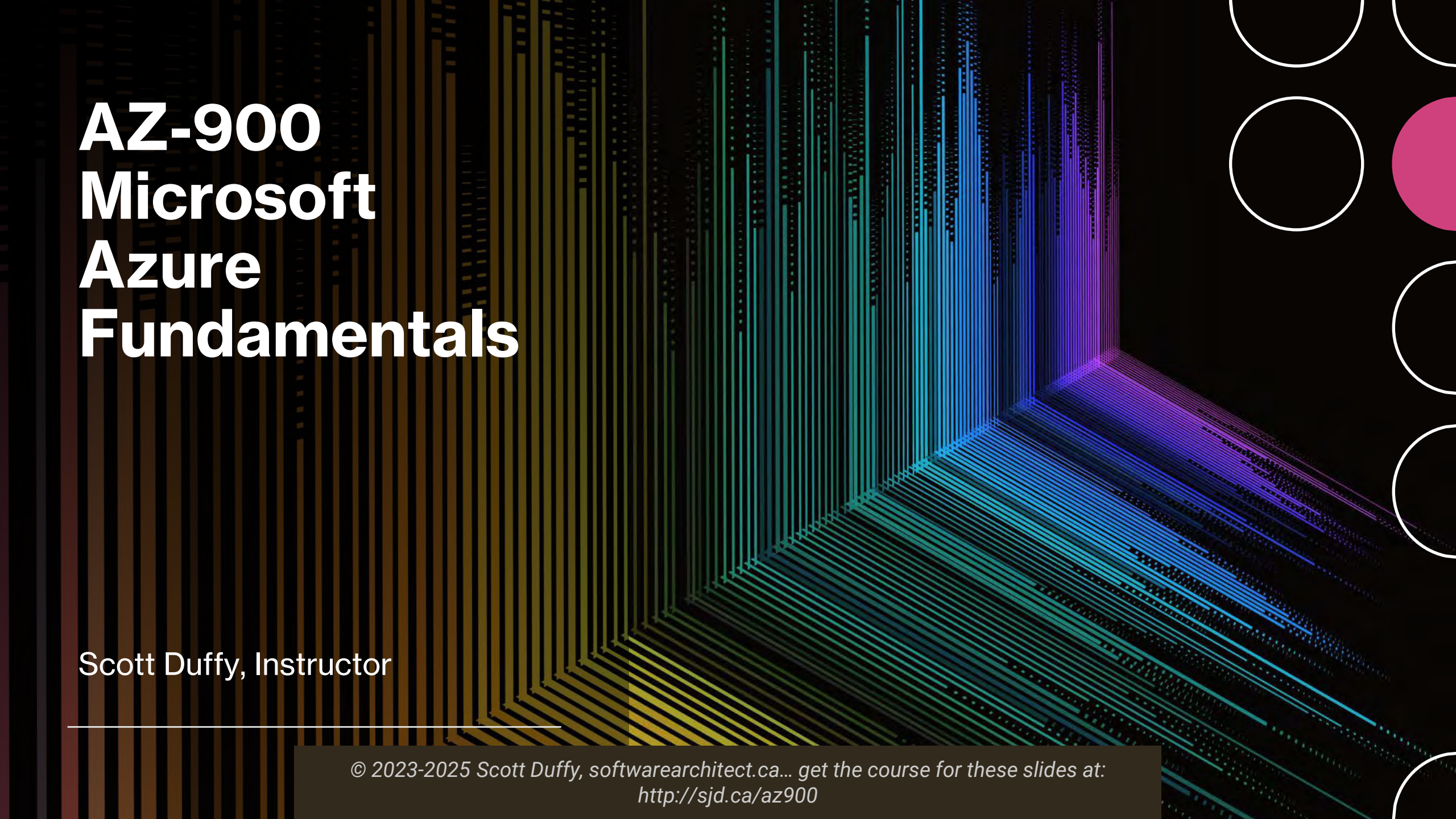

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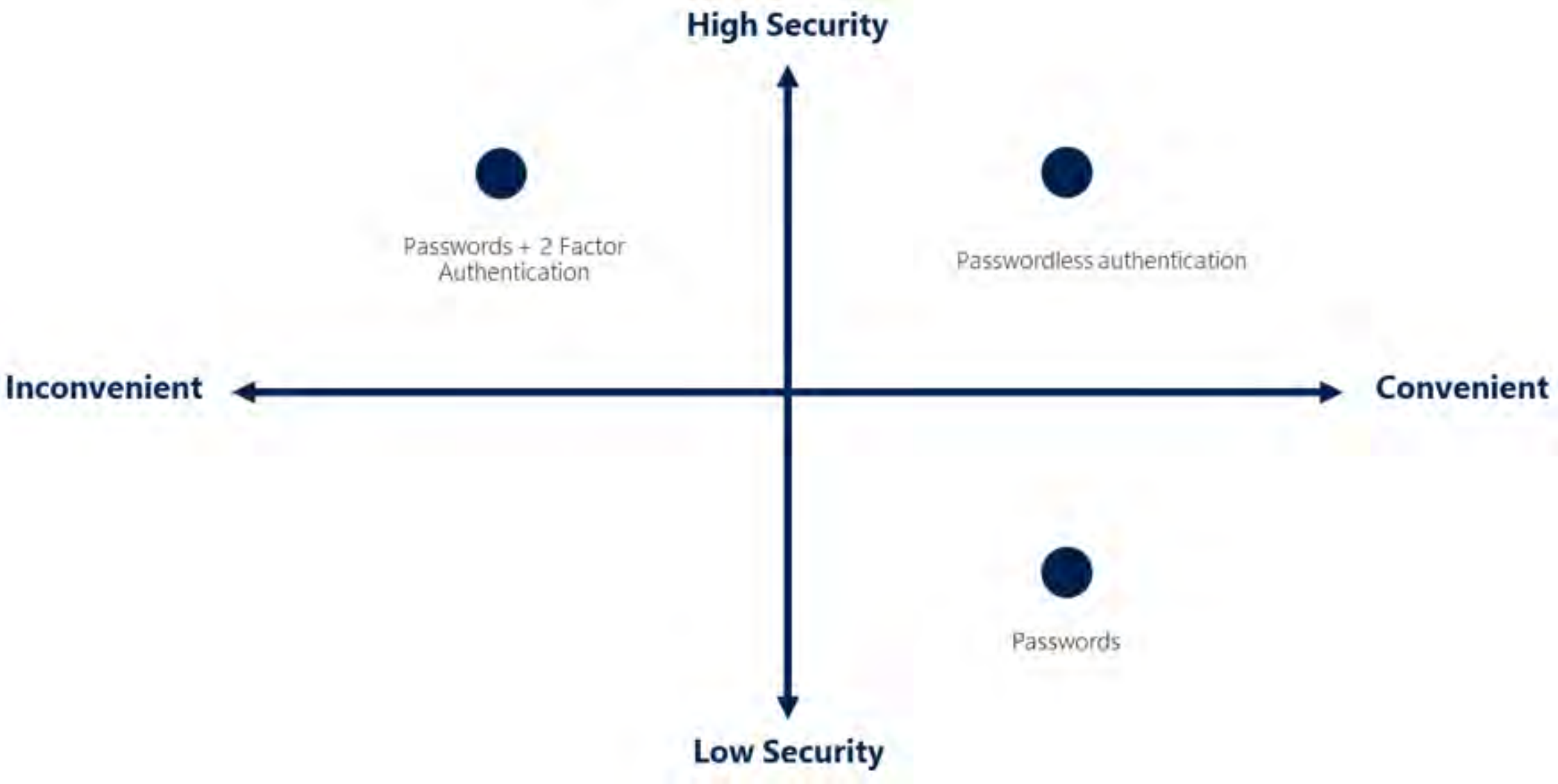
Passwordless

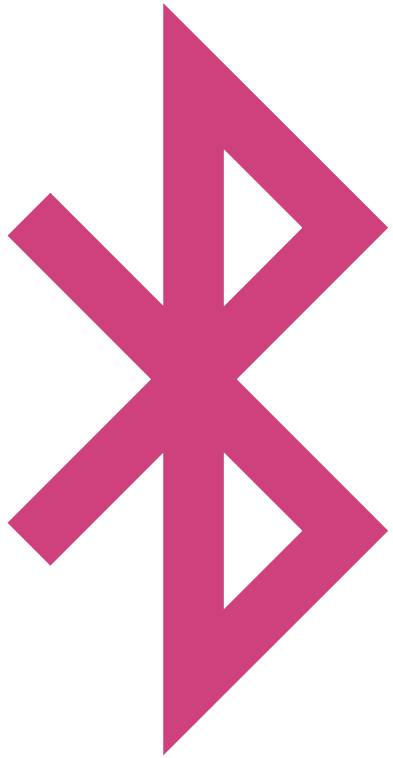

High Security
Passwords + 2 Factor Authentication
Passwordless authentication
Inconvenient
Convenient
Passwords
Low Security


Using a PIN or biometric recognition with Windows devices
(Iris, face, fingerprint)

Hello data kept on the device



Auto-lock the device when you’re away (via Bluetooth)

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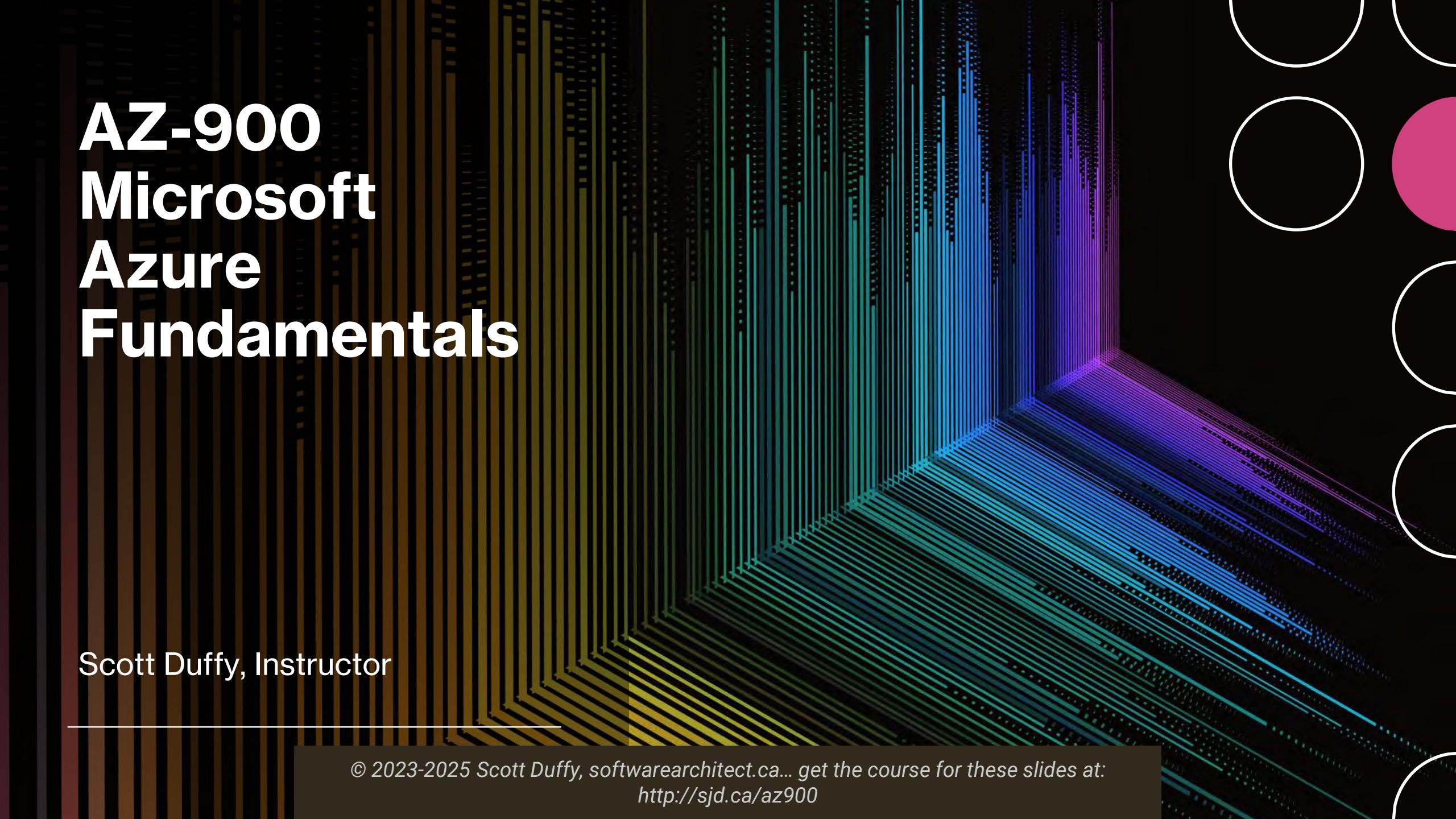

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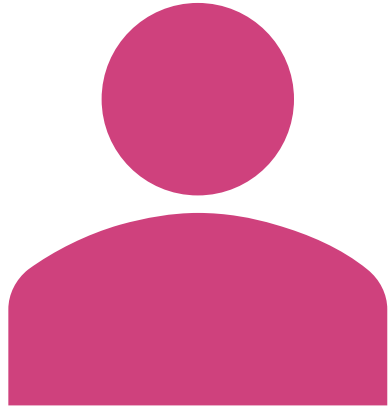
Role-Based Access Control (RBAC)



Microsoft's preferred solution for authorization



Developer
Operations
IT Security



You try to get granular with the assignments

(Principle of Least Privilege)





Assign users to those roles

Try to avoid exceptions where User X has admin privileges that you don’t expect

Three Basic Roles

Reader

Contributor

Owner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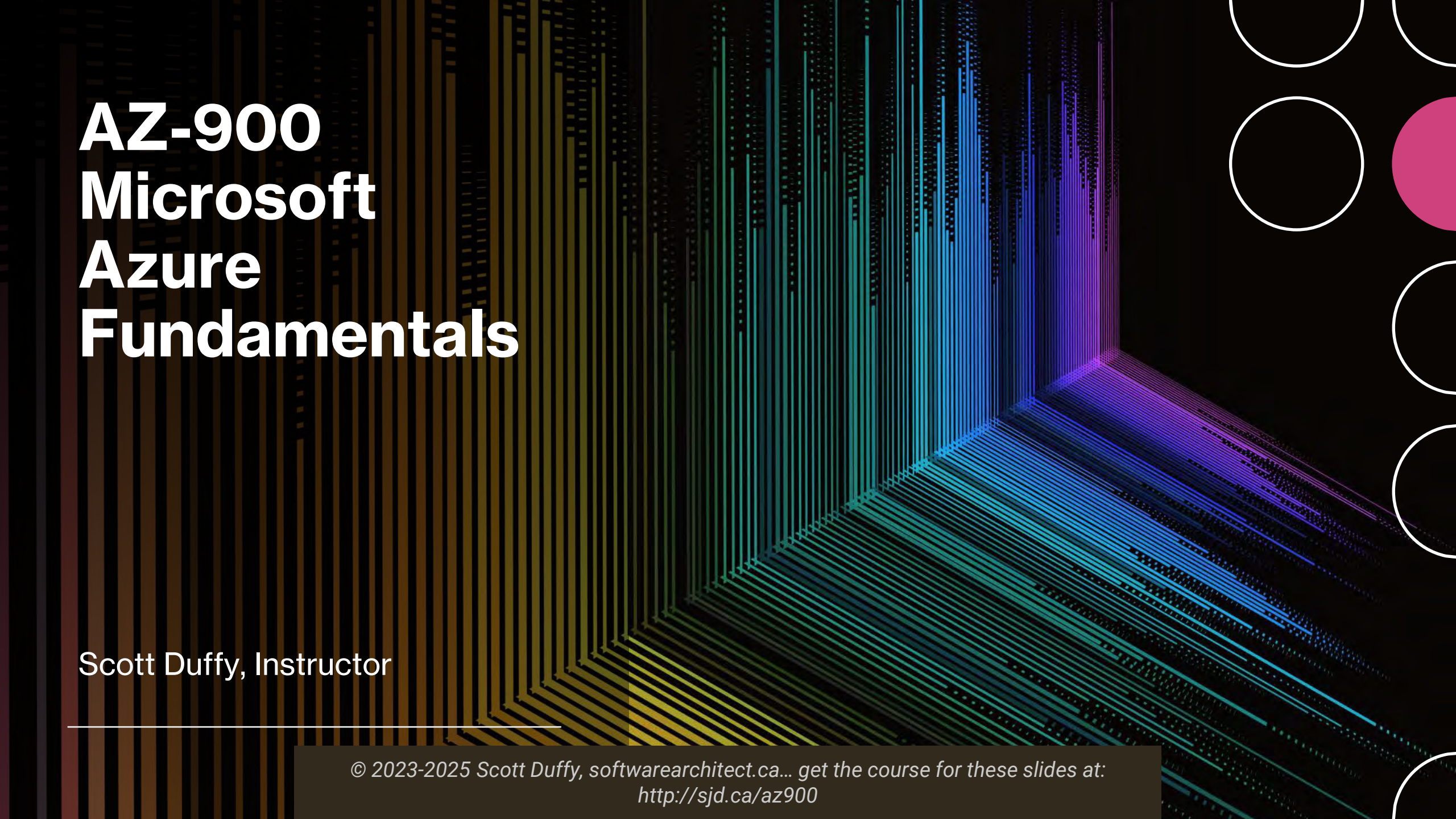

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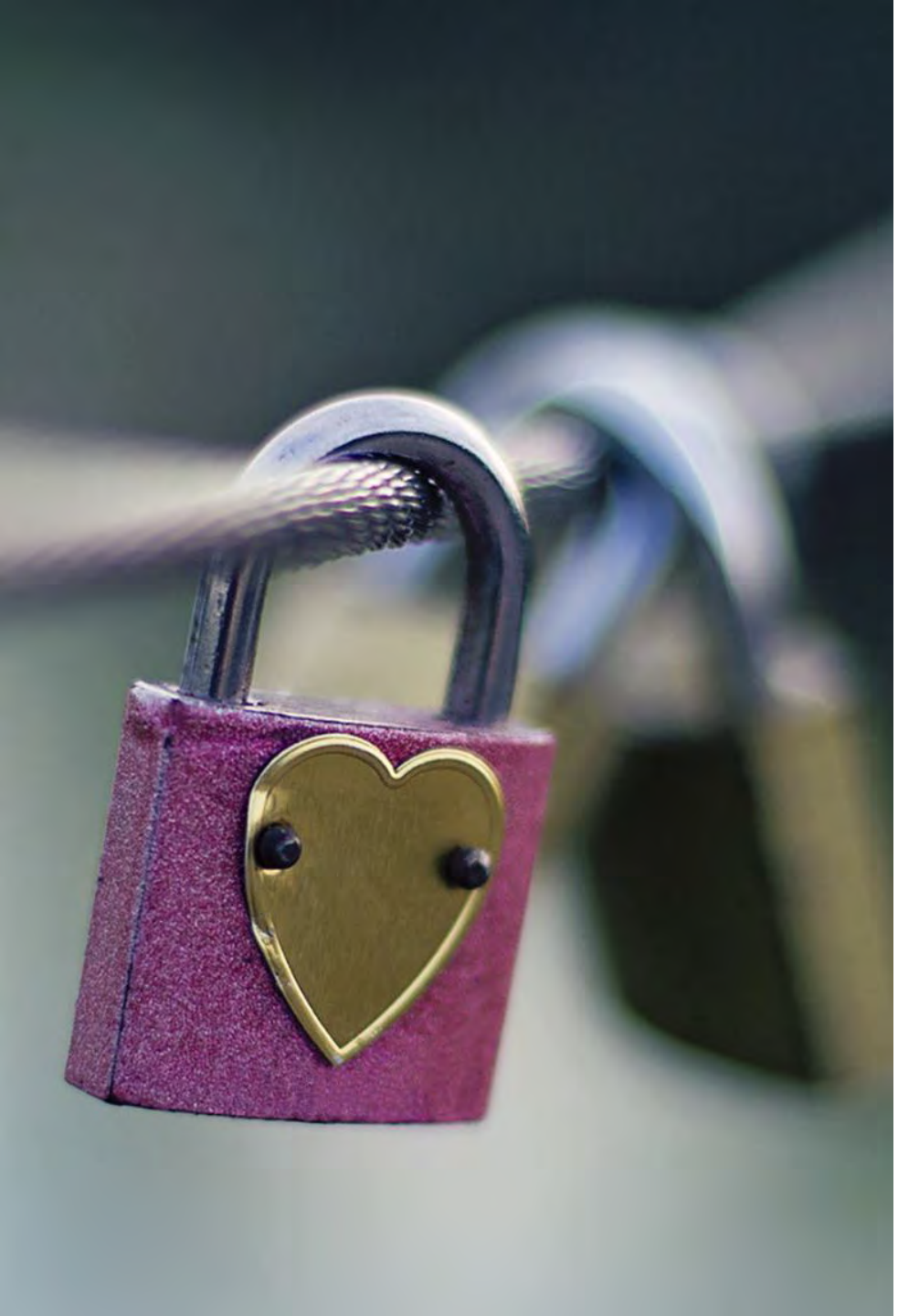
Zero Trust Model



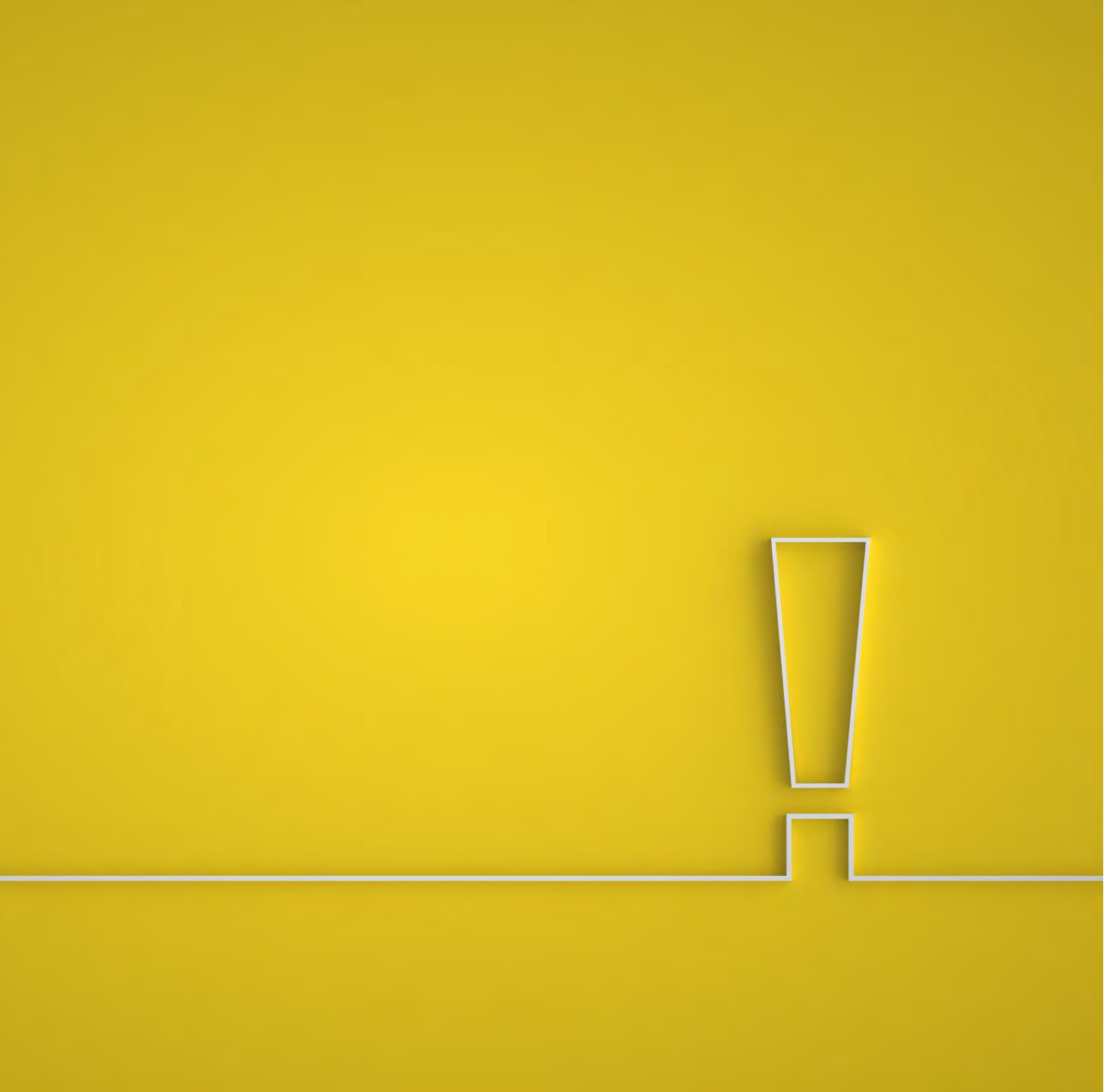
At one point in time...

- IT security was focused on protecting “the border” – the boundary between the company and the public Internet (DMZ)
- Everything inside the corporate network as assumed safe



And now...

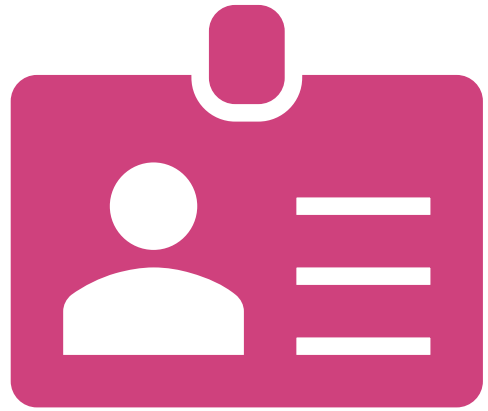
- Can’t trust any connection regardless where it comes from
- Force everyone to prove their identity



Zero Trust Principles

- Verify explicitly
- Use least privileged access
- Assume breach

Use every available method to validate identity and authorization



Just-in-time (JIT)

Just-enough-access (JEA)

Security even inside the network; encryption, segmentation, threat detection




Identities
Identity provider
Multi-factor authentication
User/session risk
Devices
Corporate devices
Unmanaged devices
Device inventory
Device risk & compliance state
Device identity
Organization policy
Security Policy Enforcement
Real-time policy evaluation
Threat intelligence
Classify, label, encrypt
Adaptive access
Access & runtime control
Threat protection
Data
Email & documents
Structured data
Apps
SaaS apps
On-premise apps
Infrastructure
IaaS
PaaS
Int. Sites
Container
Serverless
JIT and version control
Network
Network delivery
Internal Micro-segmentation
Visibility and analytics
Automation

Identity: Verify and secure each identity

Devices: ensure compliance and health status

Applications: appropriate in-app permissions, monitor user actions

Data: data-driven protection, encrypt and restrict access

Infrastructure: robust monitoring to detect attacks, block and flag risky behavior

Network: encrypt all communications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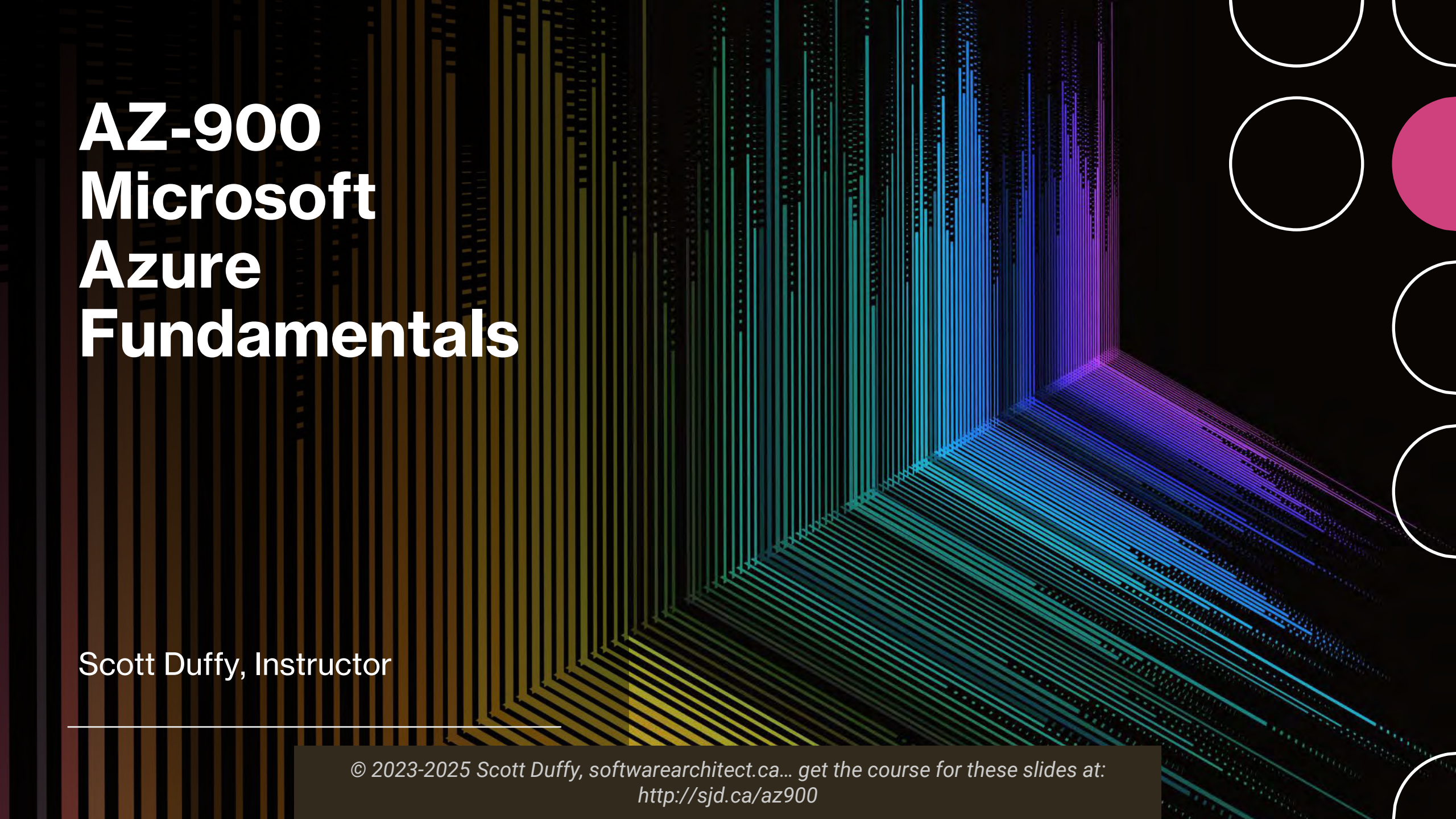

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Defence in Depth

Security Layers

- Data - i.e. virtual network endpoint
- Application - i.e. API Management
- Compute - i.e. Limit Remote Desktop access, Windows Update
- Network - i.e. NSG, use of subnets, deny by default
- Perimeter - i.e. DDoS, firewalls
- Identity & access - i.e. Entra ID
- Physical - i.e. Door locks and key cards

Defense in Depth

Identity & Access	Apps & Data Security	Network Security	Threat Protection	Security Management
Role-based access	Encryption	DDOS Protection	Antimalware	Log Management
Multifactor Authentication	Confidential Computing	NG Firewall	AI-Based Detection and Response	Security Posture Assessment
Central Identity Management	Key Management	Web App Firewall	Cloud Workload Protection	Policy and Governance
Identity Protection	Certificate Management	Private Connections	SQL Threat Protection	Regulatory Compliance
Privileged Identity Management	Information Protection	Network Segmentation	IoT Security	SIEM


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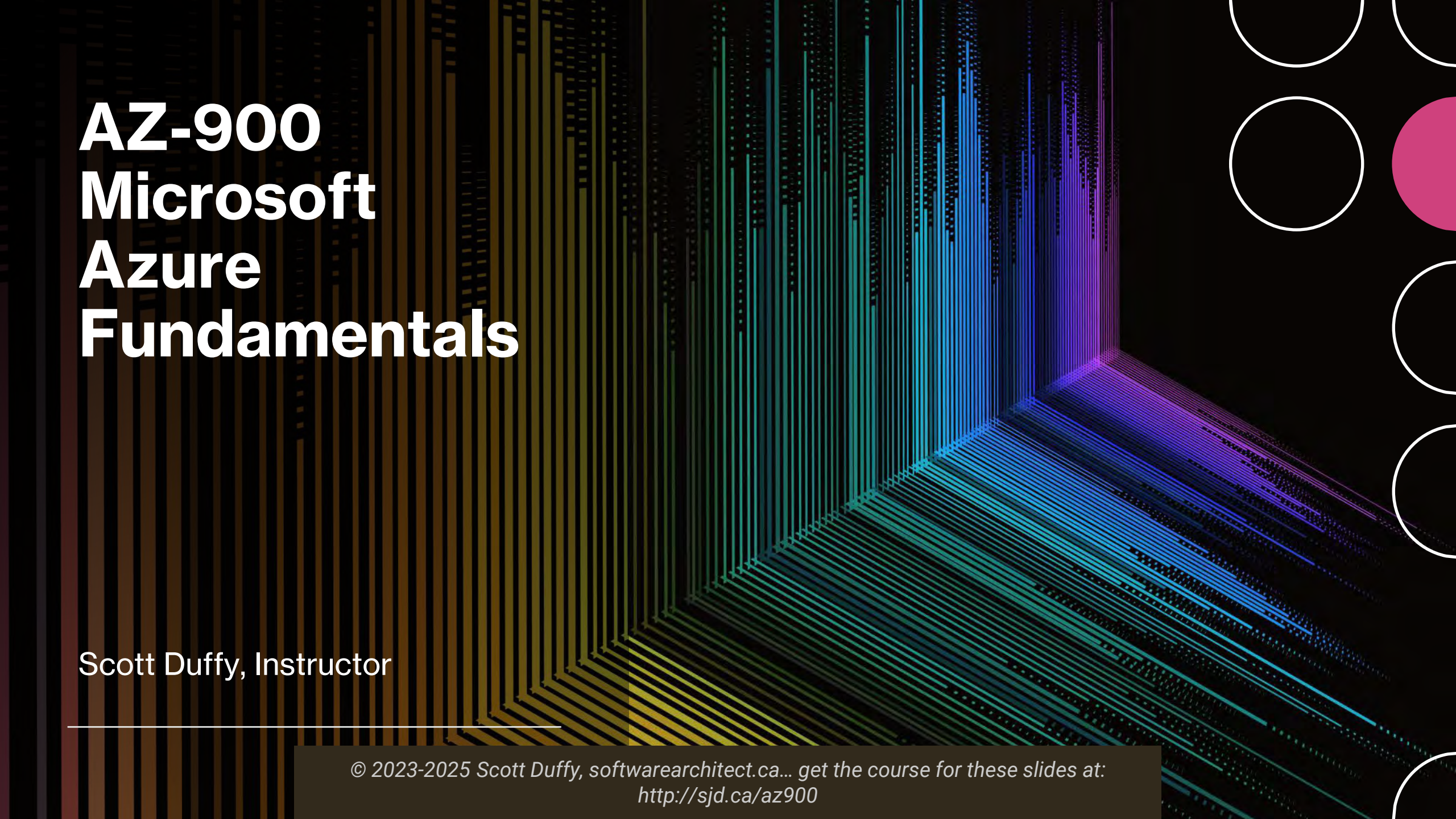

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Describe Azure Management and Governance (30–35%)

Describe Azure management and governance (30–35%)

Describe cost management in Azure

- Describe factors that can affect costs in Azure
- Compare the pricing calculator and the Total Cost of Ownership (TCO) Calculator
- Describe cost management capabilities in Azure
- Describe the purpose of tags

Describe features and tools in Azure for governance and compliance

- Describe the purpose of Microsoft Purview in Azure
- Describe the purpose of Azure Policy
- Describe the purpose of resource locks

Describe features and tools for managing and deploying Azure resources

- Describe the Azure portal
- Describe Azure Cloud Shell, including Azure Command-Line Interface (CLI) and Azure PowerShell
- Describe the purpose of Azure Arc
- Describe infrastructure as code (IaC)
- Describe Azure Resource Manager (ARM) and ARM templates

Describe monitoring tools in Azure

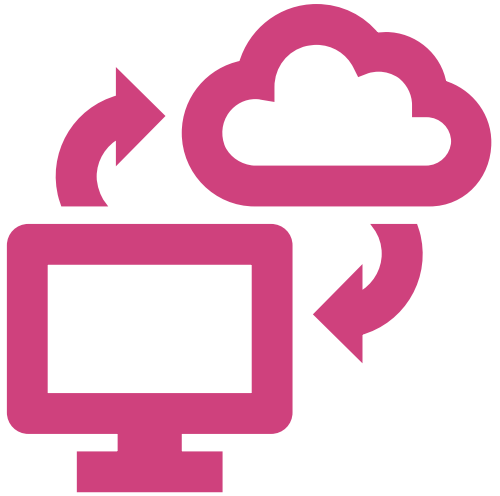
- Describe the purpose of Azure Advisor
- Describe Azure Service Health
- Describe Azure Monitor, including Log Analytics, Azure Monitor alerts, and Application Insights

Describe Cost Management

Factors that affect cost



One of the benefits of cloud computing is the flexibility in pricing options





You can choose to have relative certainty over the monthly bill...

Or choose to (possibly) save money by paying only for what you use.



Factor 1: Resource Type

Different services have different pricing structures:

- VMs are priced by compute time.
- charges by capacity and redundancy.
- Networking may include data transfer costs.

Factor 2: Usage and Billing Model

Azure offers flexible pricing models:

- **Pay-as-you-go**: billed based on actual usage
- **Reserved instances**: save with 1- or 3-year precommitments
- **Spot pricing**: deep discounts for interruptible workloads

Factor 3: Service Tiers and Configuration

Services come in multiple SKUs or tiers:

- Example: App Service – Free, Basic, Standard, Premium
- Choosing more CPU, memory, or performance features increases cost
- Region choice also affects price

Factor 4: Licensing Costs

Some services include licensing, others don’t:

- Extra charges for Windows or SQL Server licensing
- **Azure Hybrid Benefit** can save money if you have existing licenses

Factor 5: Data Transfer (Bandwidth)

- **Inbound data** is usually free
- **Outbound data** is charged beyond a free tier
- **Inter-region transfers** also cost money

Factor 6: Idle or Unused Resources

You may be charged even if a resource isn’t in use:

- Running a VM that does nothing still costs money
- Reserved IPs and orphaned disks can also generate charges

Factor 7: Additional Considerations

- access tiers: Hot, Cool, Archive
- Read/write operations on can have micro-costs
- Marketplace services may add third-party fees

Tools to Estimate and Control Costs

Azure offers tools to plan and manage expenses:

- **Azure Pricing Calculator**: try out configurations
- **Cost Management + Billing**: monitor and optimize actual usage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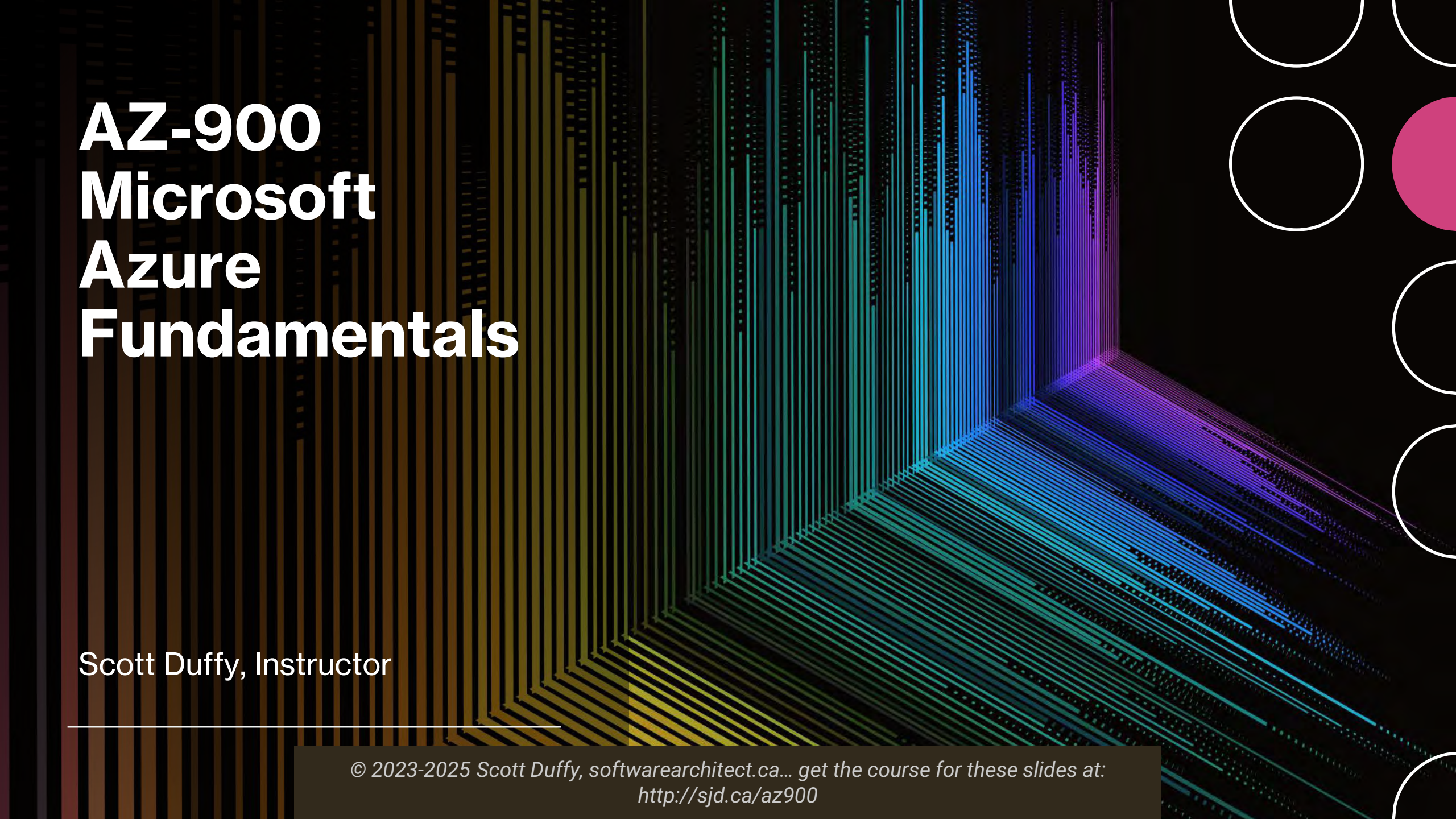

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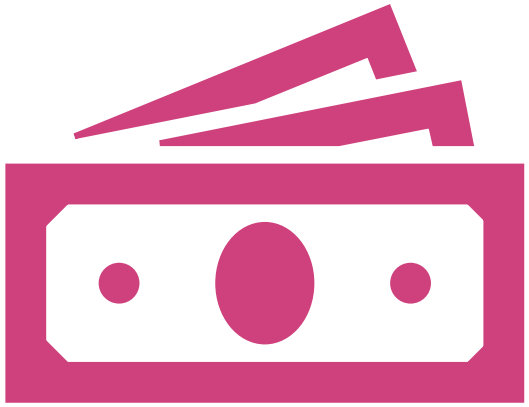
Azure Cost Management



A free tool inside Azure Portal to analyze spending



Pay-As-You-Go (Azure Courses) | Cost analysis

Subscription

Search (Ctrl+/)

Overview
Activity log
Access control (IAM)
Tags
Diagnose and solve problems
Security
Events

Cost Management
Cost analysis
Budgets
Advisor recommendations

Billing
Invoices
External services
Payment methods
Partner information

Save | Save as | Delete view | Share | Refresh | Download | Settings | Try preview | Help

Scope : Scott's Course Management Group | VIEW * Accumulated costs | Invoice (Azure) : Jul 7-Aug 6 | Add filter

ACTUAL COST (CAD ONLY)
CA$115.37

FORECAST UNAVAILABLE
--

BUDGET: AZBUDGET
CA$100

Group by: None | Granularity: Accumulated | Area



Service name
storage CA$46....
virtual machines CA$39....

Location
us central CA$59....
us west CA$37....

Resource group name
firstvnet-rg CA$37....
az304new CA$37....



Analyze spending over time

Tracking against budgets

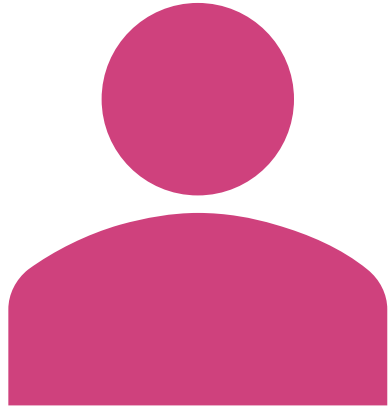


All your past invoices

Schedule reports

Resource Tags

Can add metadata to Azure resources



Helps with billing and support issues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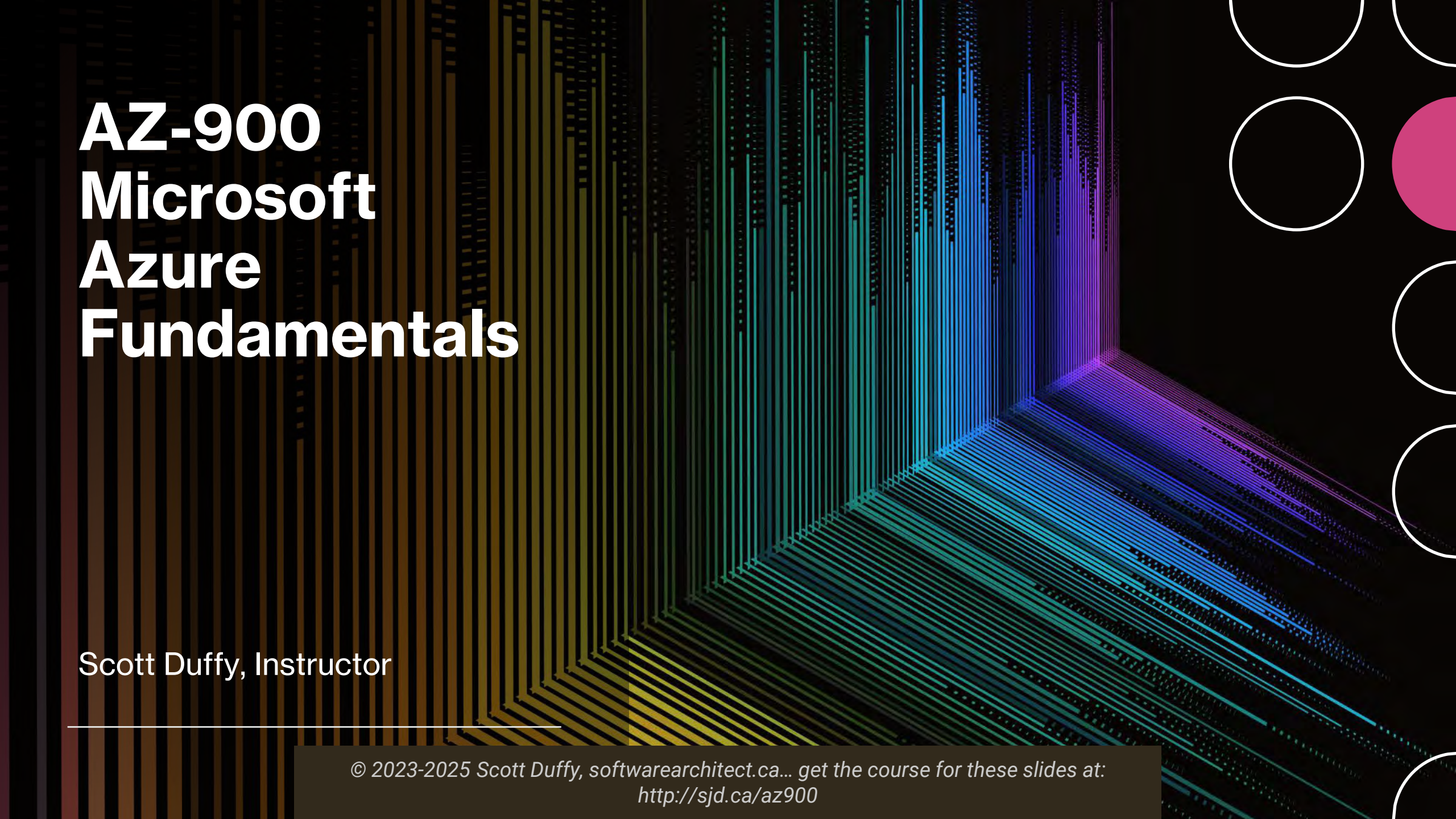

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Governance and Compliance



Can also be a formal group like IT Security Committee or Architecture Review



Types of Rules

- All servers must be running software within Microsoft Extended Support guidelines
- All servers must be backed up every 24 hours at a minimum
- Firewalls must block all inbound ports from the Internet except 443
- Only Operations Support can reboot a production server

Can either just post the rules somewhere...



Get the platform to audit or enforce the rules.

Governance and Compliance in Microsoft azure

- Azure Blueprints will be retired
- Template Specs
- Deployment Stacks
- Azure Policy
- Resource Locks
- Microsoft Purview (data governance)
- RBAC


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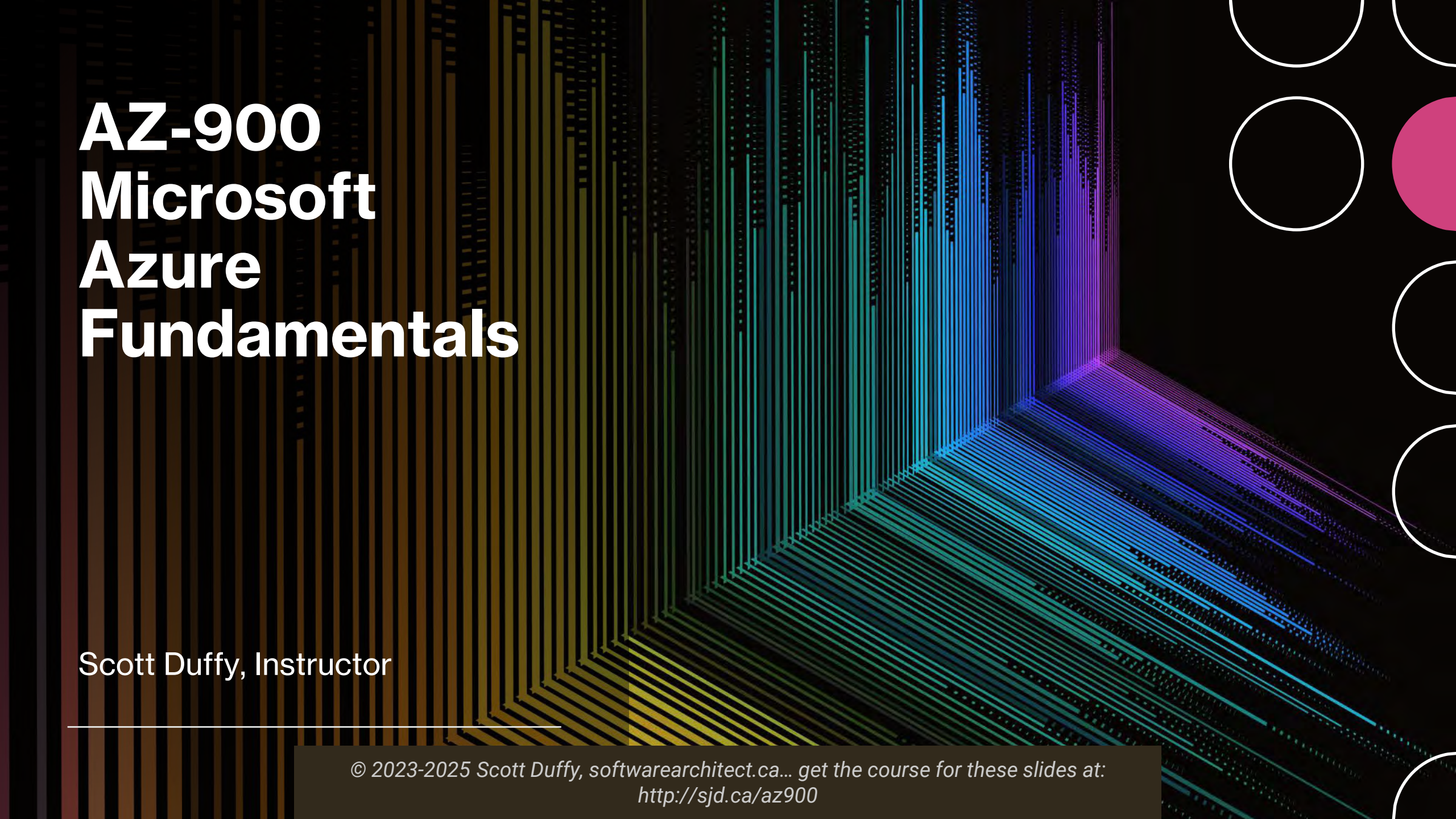

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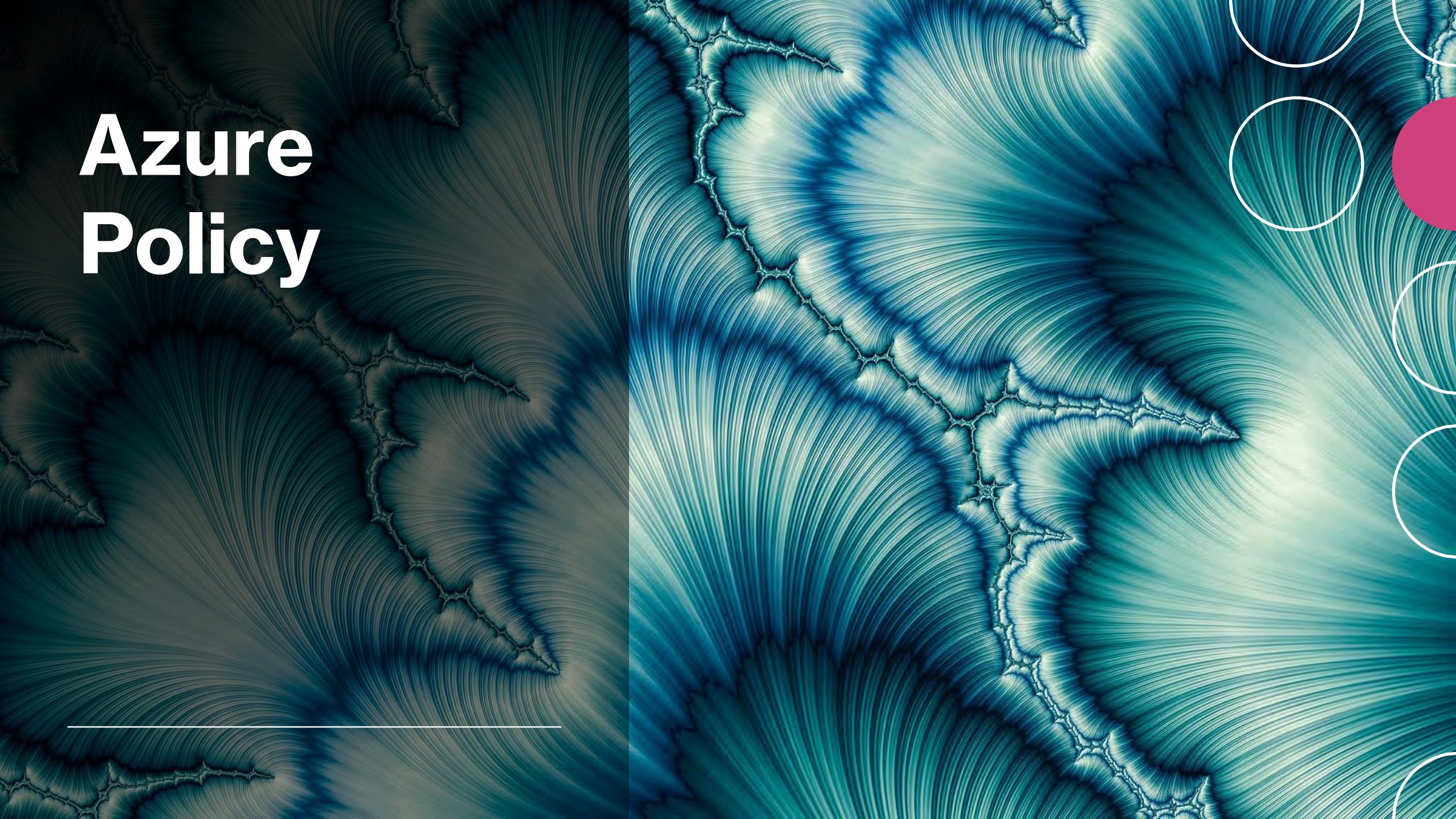
Azure Policy



Create rules for some or all your Azure resources and groups

Evaluate compliance of those rules

Examples of Policies

- Require SQL Server 12.0
- Allowed Account SKUs
- Allowed deployment locations
- Allowed VM SKUs
- Automatically apply tagging
- Not allowed resource types

Can create a custom policy using JSON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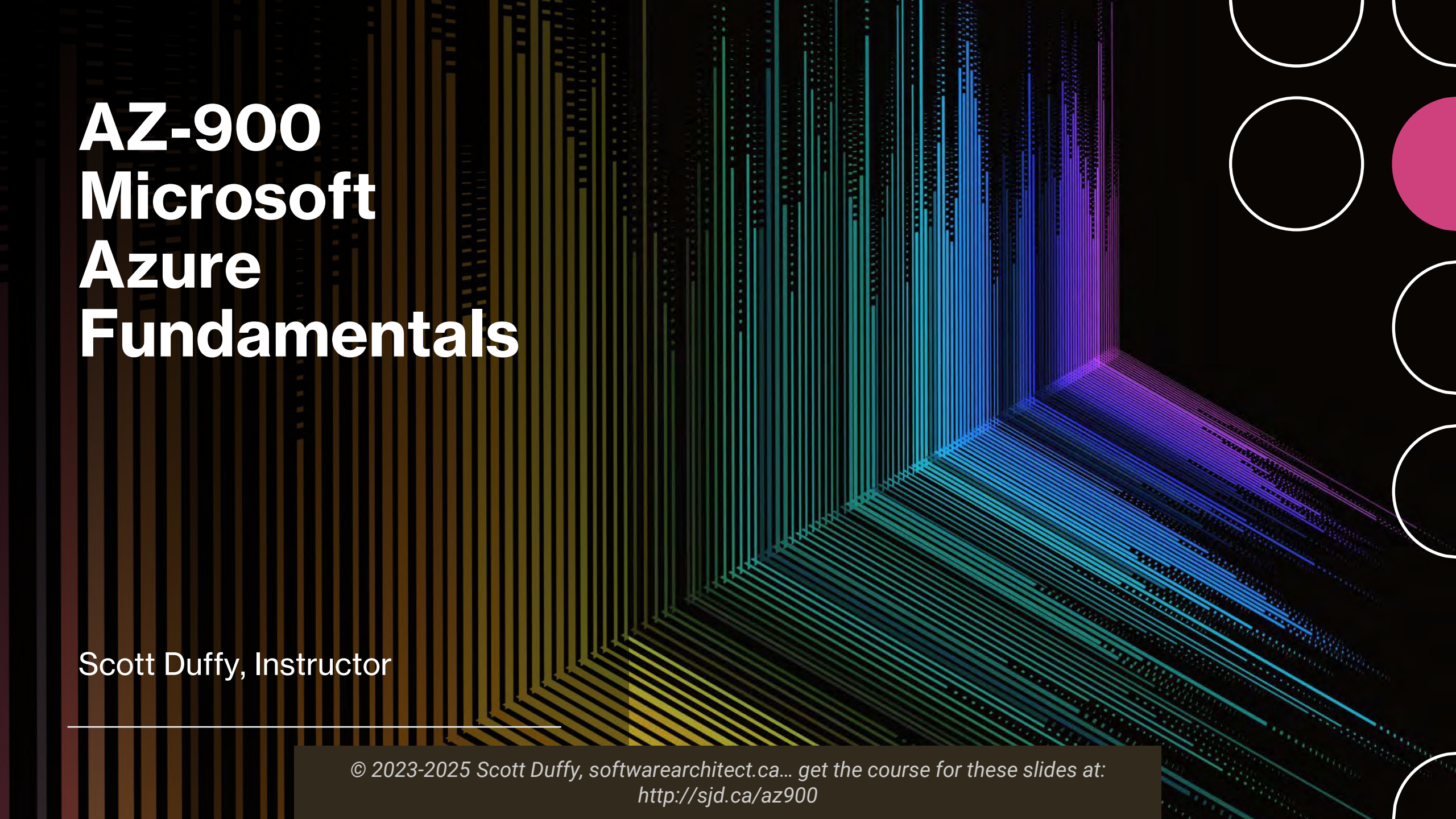

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Resource Locks

What Are They?

- The ability to restrict the modification or deletion of a resource

- Prevents accidental (or malicious) deletion of critical resources

Many people may need access to a resource (like to restart a VM), but deleting it has severe consequences

Types of Resource Locks

- Read Only
- Can Not Delete

az900course | Locks

Storage account

Search

Settings
- Configuration
- Data Lake Gen2 upgrade
- Resource sharing (CORS)
- Advisor recommendations
- Endpoints
- Locks

Monitoring
- Insights
- Alerts
- Metrics
- Workbooks
- Diagnostic settings
- Logs

Monitoring (classic)
- Metrics (classic)
- Diagnostic settings (classic)

Add | Resource group | Subscription | Refresh | Feedback

Add lock

Lock name *
donotdelete

Lock type *
Delete
- Read-only
- Delete

Notes
This is the production storage

OK | Cancel

ype | Notes

Scope

- At the:
  - Resource level
  - Resource group level
  - Subscription level

Even if you own the resource, a lock will prevent you from deleting/modifying the resource until you remove the lock





Using RBAC, you can restrict who can unlock

Add role

SqlMI Migra
SqlVM Migra
Storage Acc
Storage Acc
Storage Acc
Storage Acc
Storage Acc
Storage Blob
Storage Blob
Storage Blob
Storage Blob
Storage File
Storage File
Storage File
Storage File
Storage File

Review + a

Storage Account Admin Custom

CustomRole

Permissions | JSON | Assignments

```
20              "Microsoft.Storage/storageAccounts/PrivateEndpointConnectionsApproval/action",
21              "Microsoft.Storage/storageAccounts/failover/action",
22              "Microsoft.Storage/storageAccounts/listkeys/action",
23              "Microsoft.Storage/storageAccounts/regeneratekey/action",
24              "Microsoft.Storage/storageAccounts/rotateKey/action",
25              "Microsoft.Storage/storageAccounts/revokeUserDelegationKeys/action",
26              "Microsoft.Storage/storageAccounts/delete",
27              "Microsoft.Storage/storageAccounts/read",
28              "Microsoft.Storage/storageAccounts/listAccountSas/action",
29              "Microsoft.Storage/storageAccounts/listServiceSas/action",
30              "Microsoft.Storage/storageAccounts/write",
31              "Microsoft.Storage/storageAccounts/accountLocks/read",
32              "Microsoft.Storage/storageAccounts/accountLocks/write",
33              "Microsoft.Storage/storageAccounts/accountLocks/delete",
34              "Microsoft.Storage/storageAccounts/consumerDataSharePolicies/read",
35              "Microsoft.Storage/storageAccounts/consumerDataSharePolicies/write",
36              "Microsoft.Storage/storageAccounts/dataSharePolicies/delete",
37              "Microsoft.Storage/storageAccounts/dataSharePolicies/read",
38              "Microsoft.Storage/storageAccounts/dataSharePolicies/write",
39              "Microsoft.Storage/storageAccounts/encryptionScopes/read",
40              "Microsoft.Storage/storageAccounts/encryptionScopes/write",
41              "Microsoft.Storage/storageAccounts/inventoryPolicies/delete",
42              "Microsoft.Storage/storageAccounts/inventoryPolicies/read",
```



Resource locks are a weak form of security


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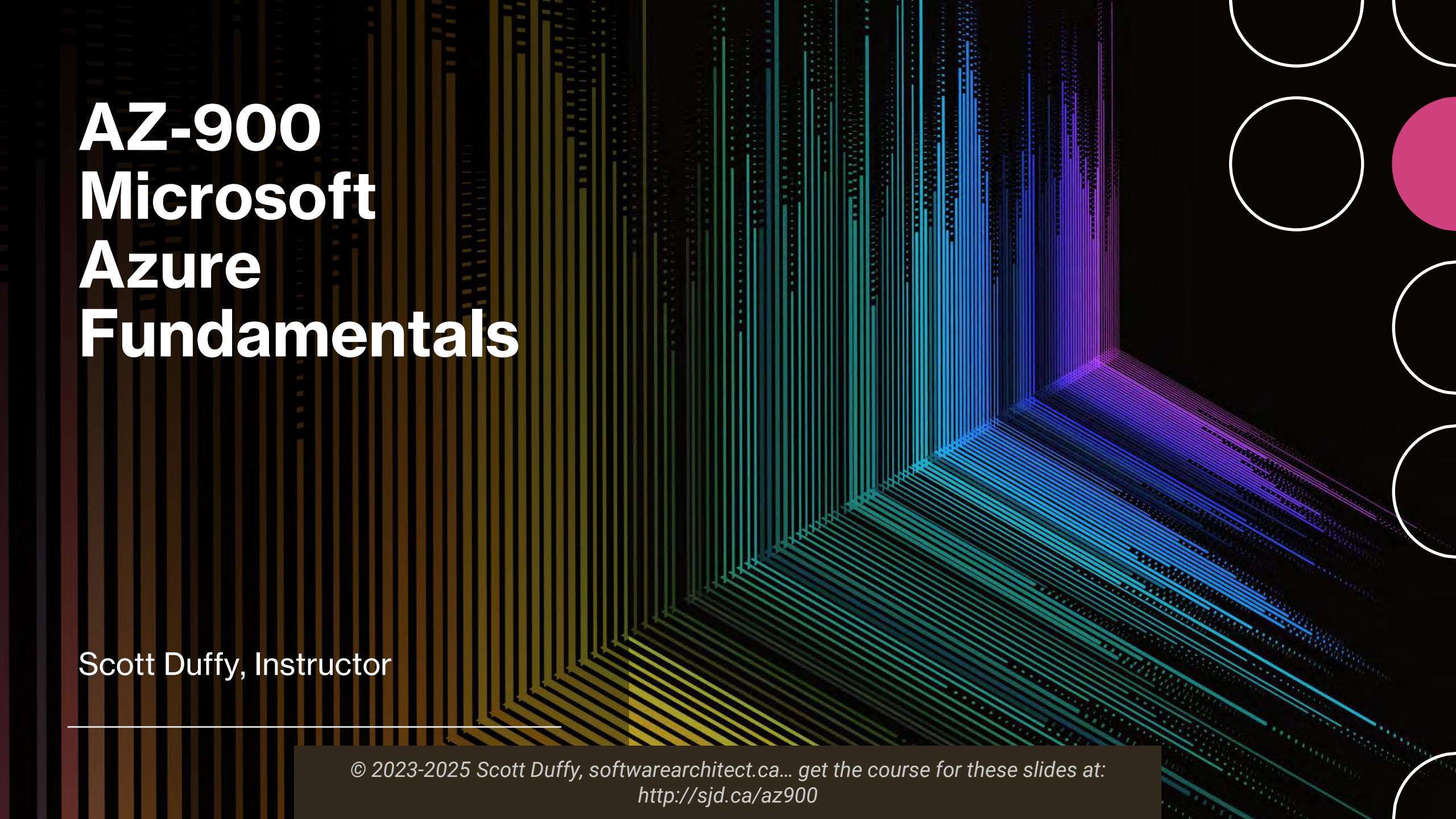

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Microsoft Purview – Data Governance

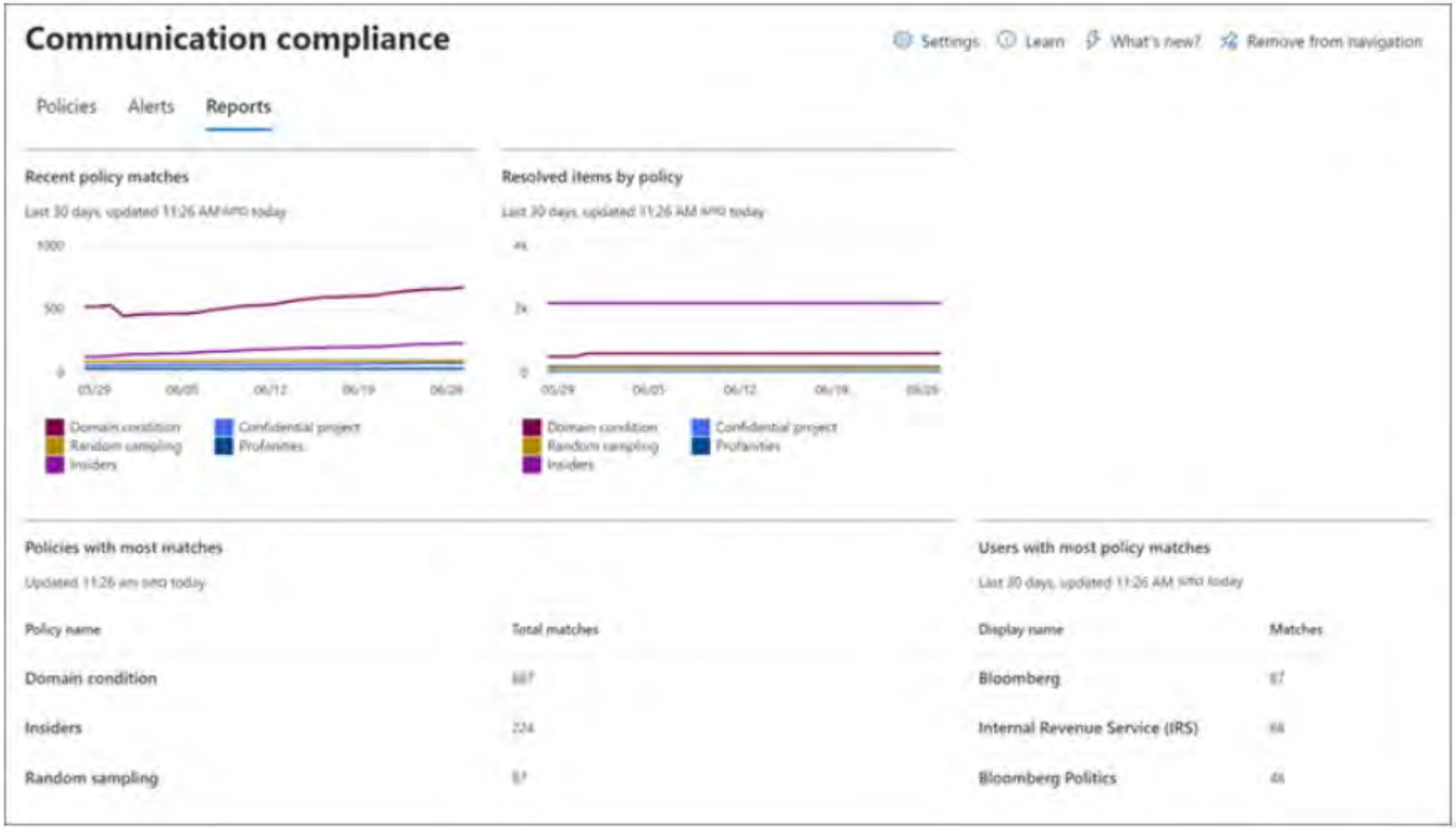


Purview

- Auditing
- Communication Compliance
- Data Map and Data Catalog
- eDiscovery
- Information Protection
- Insider Risk Management
- Data Lifecycle Management
- Data Loss Prevention
- Compliance Manager

Communication Compliance

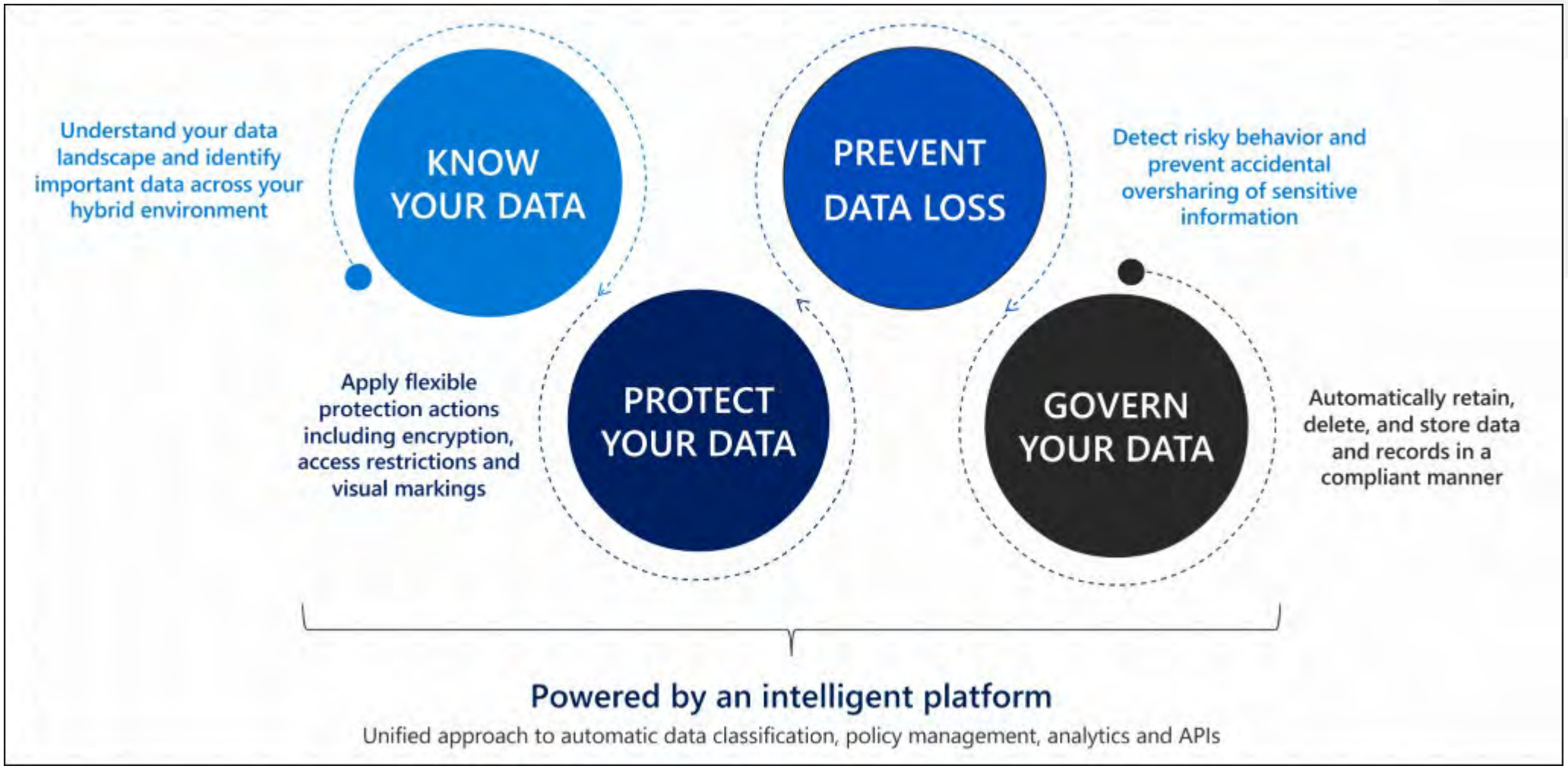
- SEC compliance
- FINRA
- Sensitive or confidential information
- Harassing or threatening language
- Sharing of adult content



Communication Compliance

Information Protection

- Know your data – what sensitive information is stored where
- Protect your data – sensitivity labels, encryption
- Prevent data loss – browser extensions, pop-up tips, block sharing, hide from chat



Information Protection

Insider Risk Management

- Identify potential malicious or inadvertent insider risks
- IP theft
- Data leakage
- Security violations

Insider Risk Management

- Data theft by departing employees
- Risky browser usage
- Repeated security policy violations
  - Install malware
  - Disable important security features
- Usual export of patient data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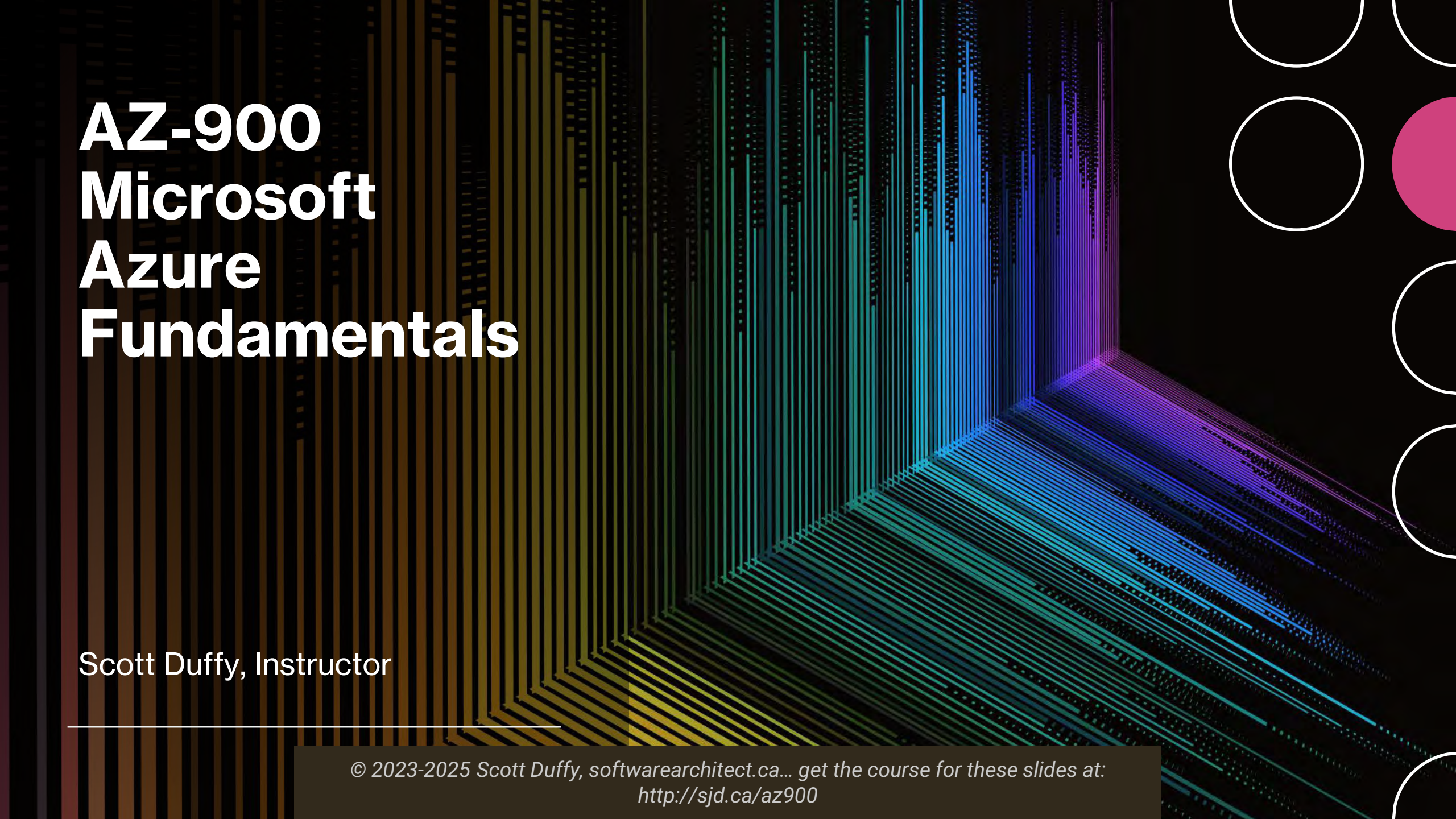

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Describe features and tools for managing and deploying Azure resources

- Describe the Azure portal
- Describe Azure Cloud Shell, including Azure Command-Line Interface (CLI) and Azure PowerShell
- Describe the purpose of Azure Arc
- Describe infrastructure as code (IaC)
- Describe Azure Resource Manager (ARM) and ARM templates


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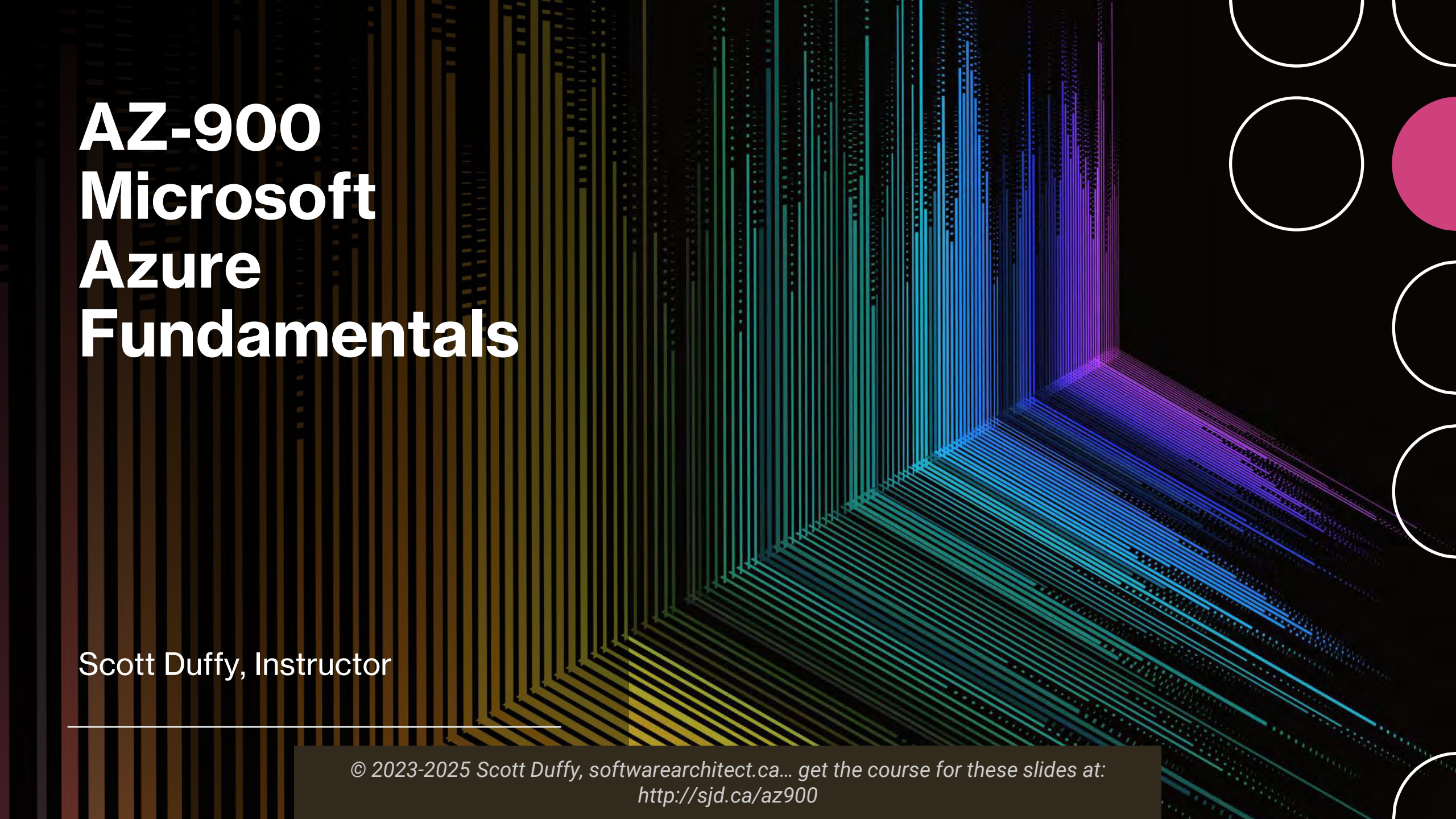

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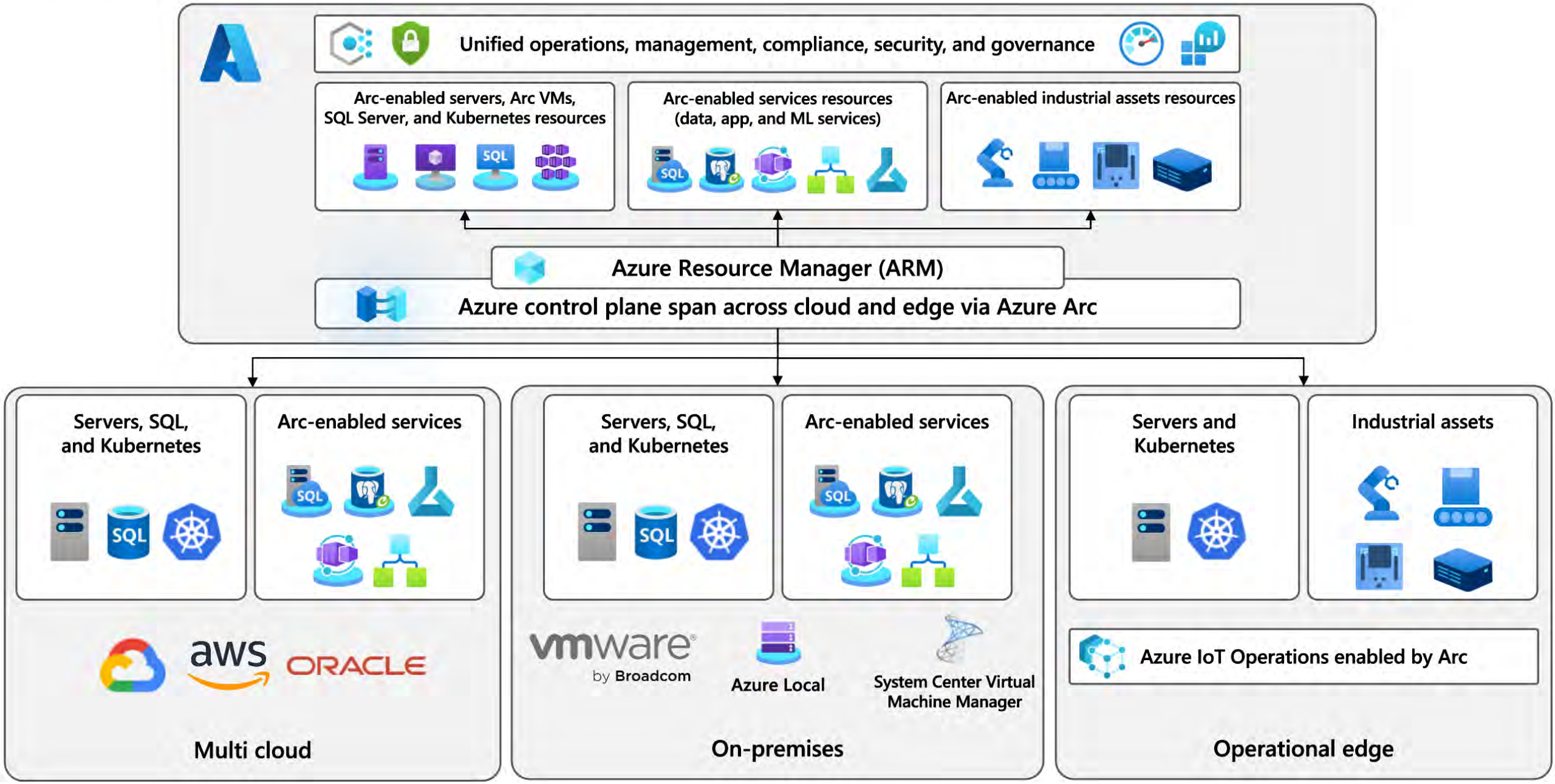
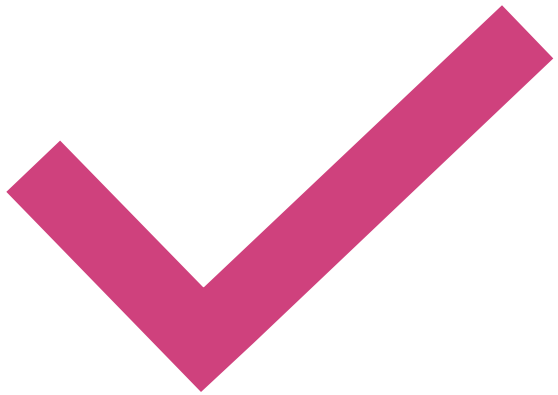
Azure Arc – Cross-Platform VM & Container Management

Use Azure to manage virtual machines, physical servers, Kubernetes clusters, databases... outside of Azure

Azure Arc solution overview architecture



VM Extensions:
- collecting logs
- running scripts
- managing OS updates



Manage SQL Server instances outside of Azure

Manage Kubernetes clusters outside of Azure

Apply Azure Policy & RBAC to Arc-enabled resources

Extended Security Updates to legacy Windows and SQL Server

Manage Windows and Linux physical servers and virtual machines outside of Azure

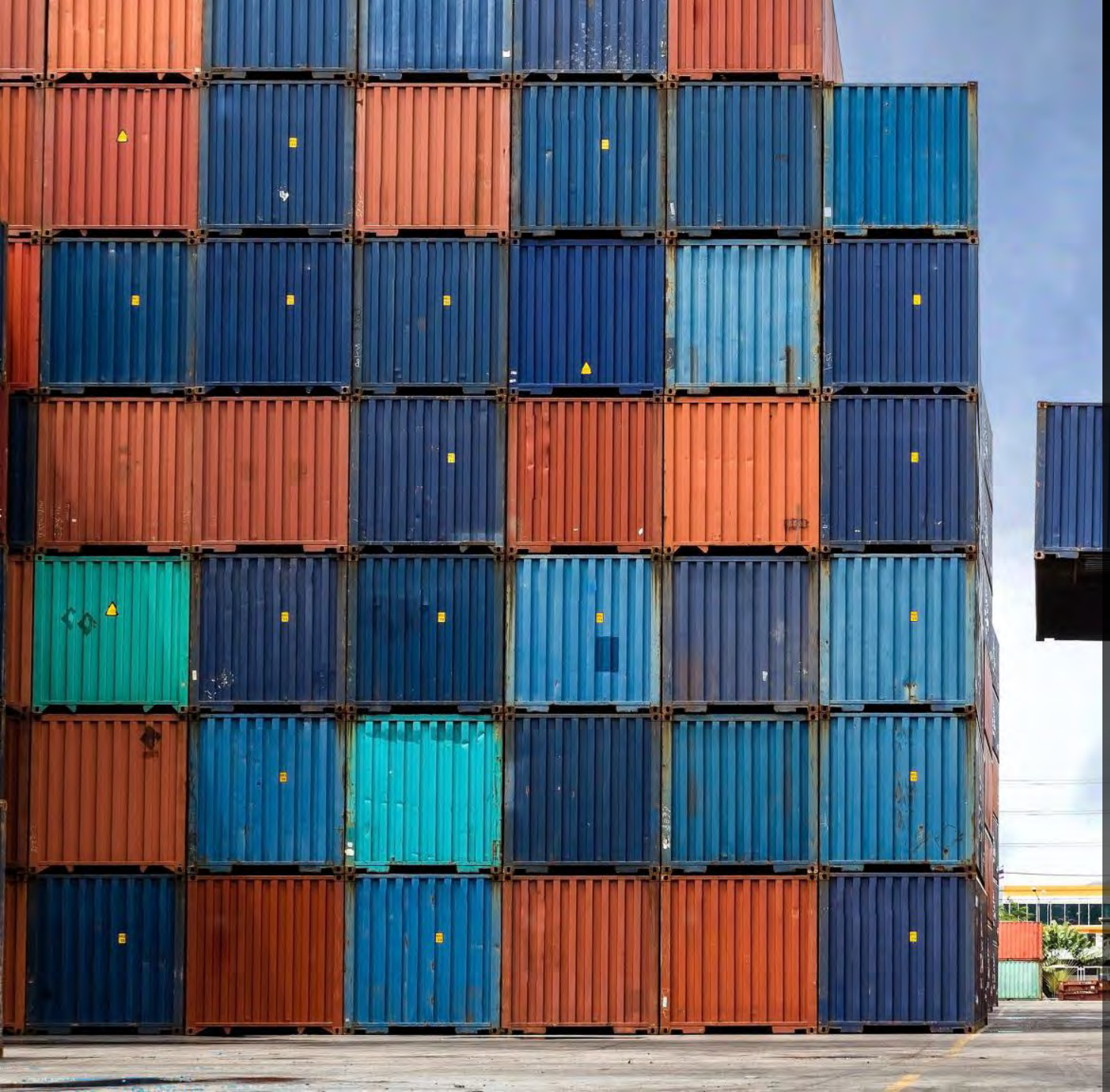
Collect performance log data into Azure Monitor

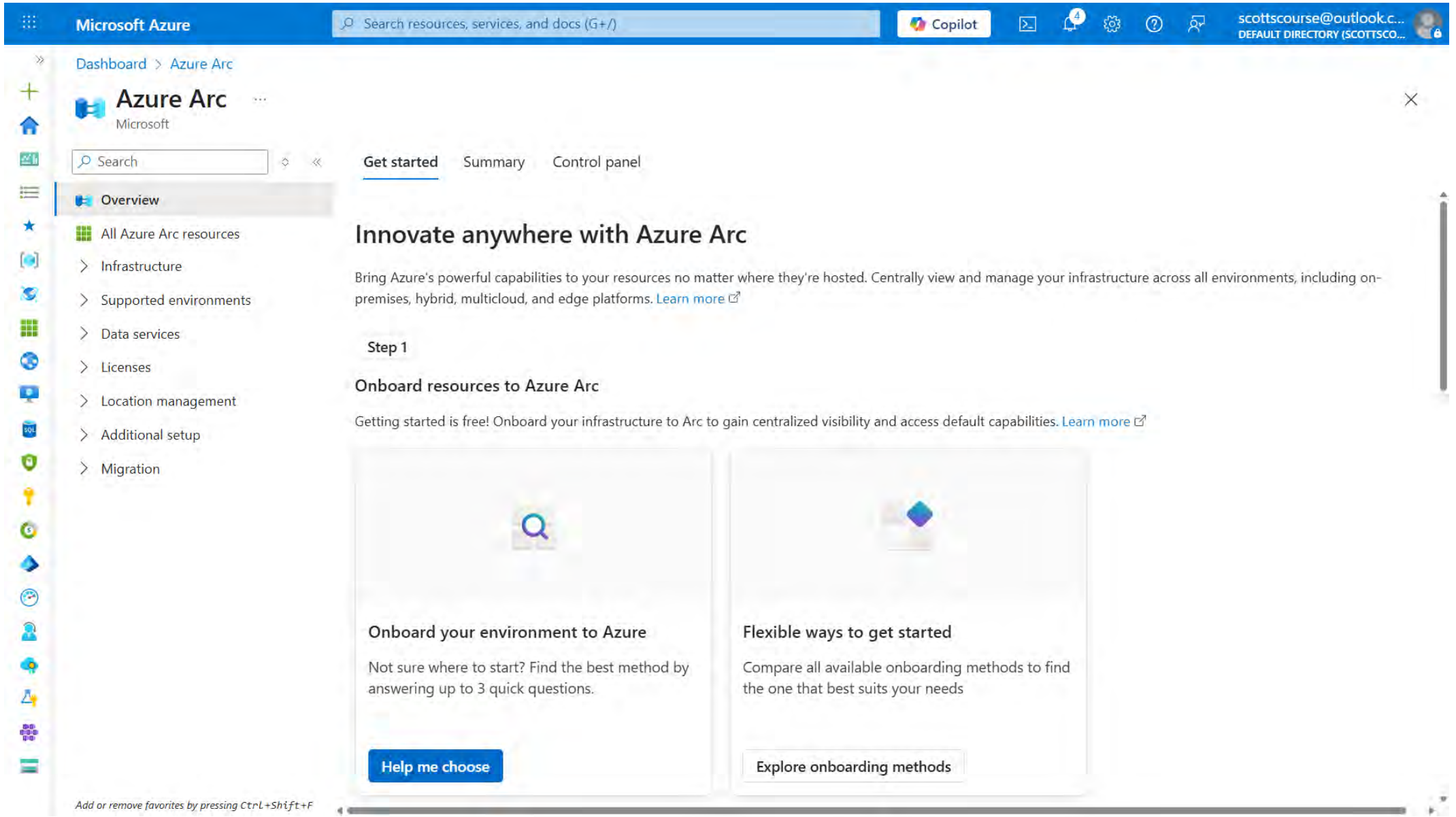
Download and execute scripts

Manage security certificates



Containers!




Microsoft Azure
Search resources, services, and docs (G+/)
Copilot
scottscourse@outlook.c...
DEFAULT DIRECTORY (SCOTTSCO...
Dashboard > Azure Arc
Azure Arc
Microsoft
Search
Overview
All Azure Arc resources
Infrastructure
Supported environments
Data services
Licenses
Location management
Additional setup
Migration
Get started
Summary
Control panel
Innovate anywhere with Azure Arc
Bring Azure's powerful capabilities to your resources no matter where they're hosted. Centrally view and manage your infrastructure across all environments, including on-premises, hybrid, multicloud, and edge platforms. Learn more
Step 1
Onboard resources to Azure Arc
Getting started is free! Onboard your infrastructure to Arc to gain centralized visibility and access default capabilities. Learn more
Onboard your environment to Azure
Not sure where to start? Find the best method by answering up to 3 quick questions.
Help me choose
Flexible ways to get started
Compare all available onboarding methods to find the one that best suits your needs
Explore onboarding methods
Add or remove favorites by pressing Ctrl+Shift+F

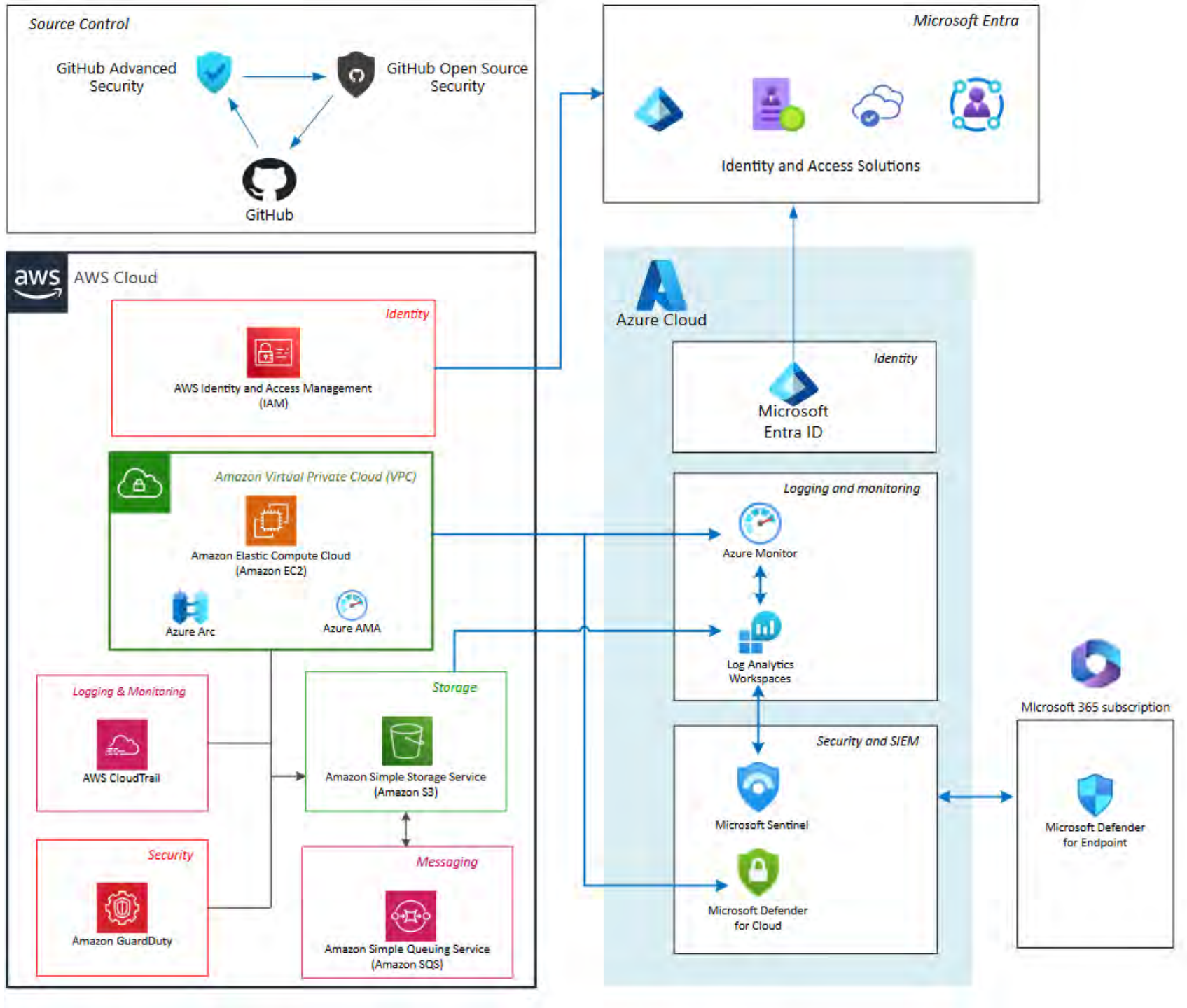
Home > Multicloud connectors >

Add AWS connector

Basics | Solutions | 3 Authentication template | 4 Tags | 5 Review and create

Add solutions you'd like to use with this connector.

Solution	Description	Default permission	Pre-requisites	Actions
Inventory	See resources from different clouds in a single inventory view. Learn more	Global read-only	None	+ Add
Arc onboarding	Add Azure Arc to use Azure management services on your EC2 instances. Learn more	EC2 read, write	None	+ Add
Storage - Data Management (Preview)	Reads data from source cloud. This is required to set up the Storage Mover data connection Learn more	S3 read-only permissions	Inventory with S3	+ Add


Source Control
GitHub Advanced Security
GitHub Open Source Security
GitHub
Microsoft Entra
Identity and Access Solutions
aws
AWS Cloud
Identity
AWS Identity and Access Management (IAM)
Amazon Virtual Private Cloud (VPC)
Amazon Elastic Compute Cloud (Amazon EC2)
Azure Arc
Azure AMA
Logging & Monitoring
AWS CloudTrail
Storage
Amazon Simple Storage Service (Amazon S3)
Security
Amazon GuardDuty
Messaging
Amazon Simple Queuing Service (Amazon SQS)
Azure Cloud
Identity
Microsoft Entra ID
Logging and monitoring
Azure Monitor
Log Analytics Workspaces
Security and SIEM
Microsoft Sentinel
Microsoft Defender for Cloud
Microsoft 365 subscription
Microsoft Defender for Endpoint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Azure Arc Features

- Consistent management for servers across your environment
- Azure VM extensions allows Azure tools to work for monitoring, security, and updates
- Supports data services
- Works with Kubernetes clusters
- Works with Azure Policy

Servers

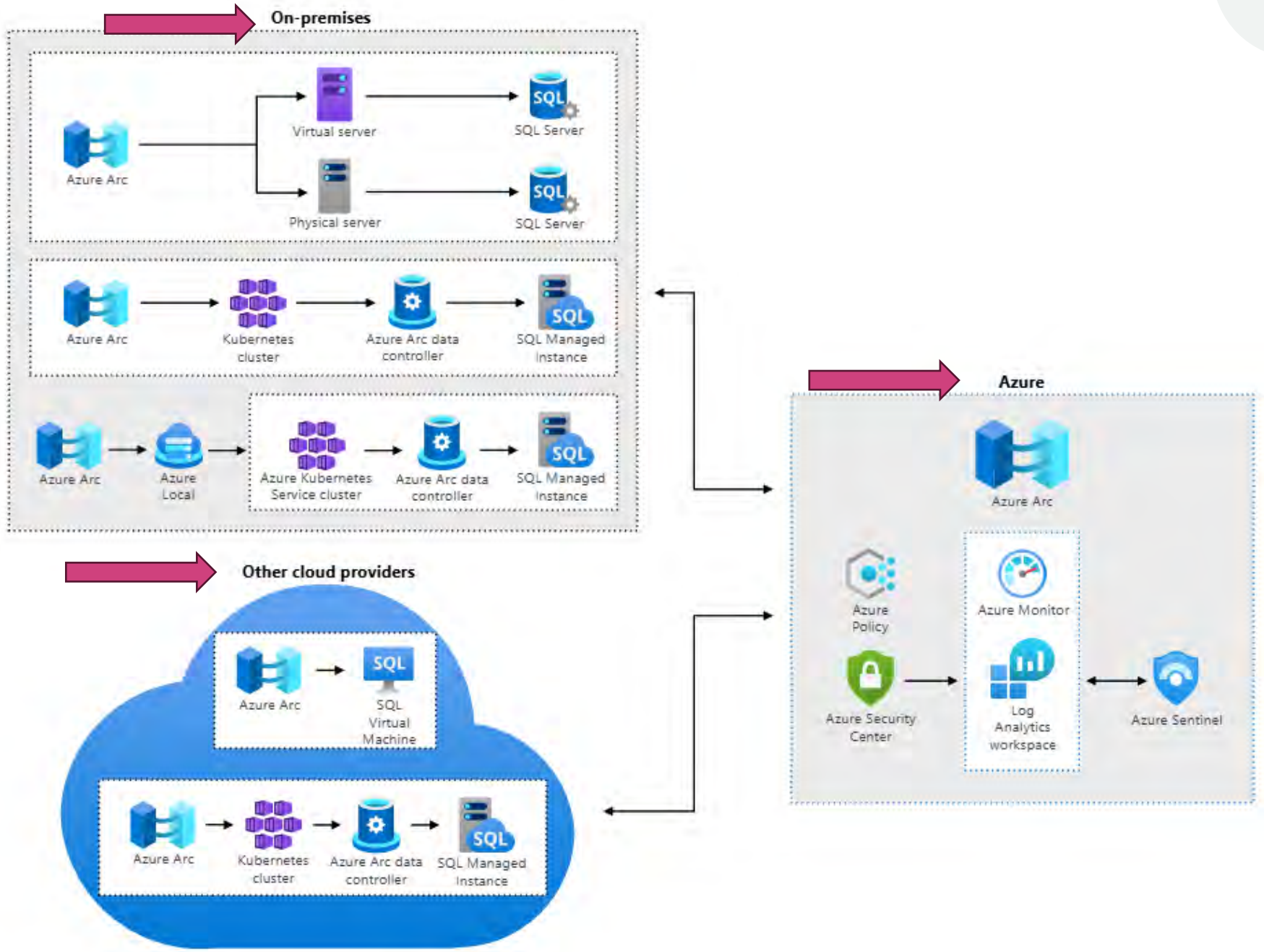
Install Azure VM extensions on non-Azure Windows and Linux VMs

What can you do?

- Collect log data for Log Analytics and Monitor
- Use VM Insights to analyze performance
- Download and execute scripts to hybrid connected machines
- Refresh certification using Key Vault

Kubernetes

Attach and manage Kubernetes clusters running anywhere



Microsoft Azure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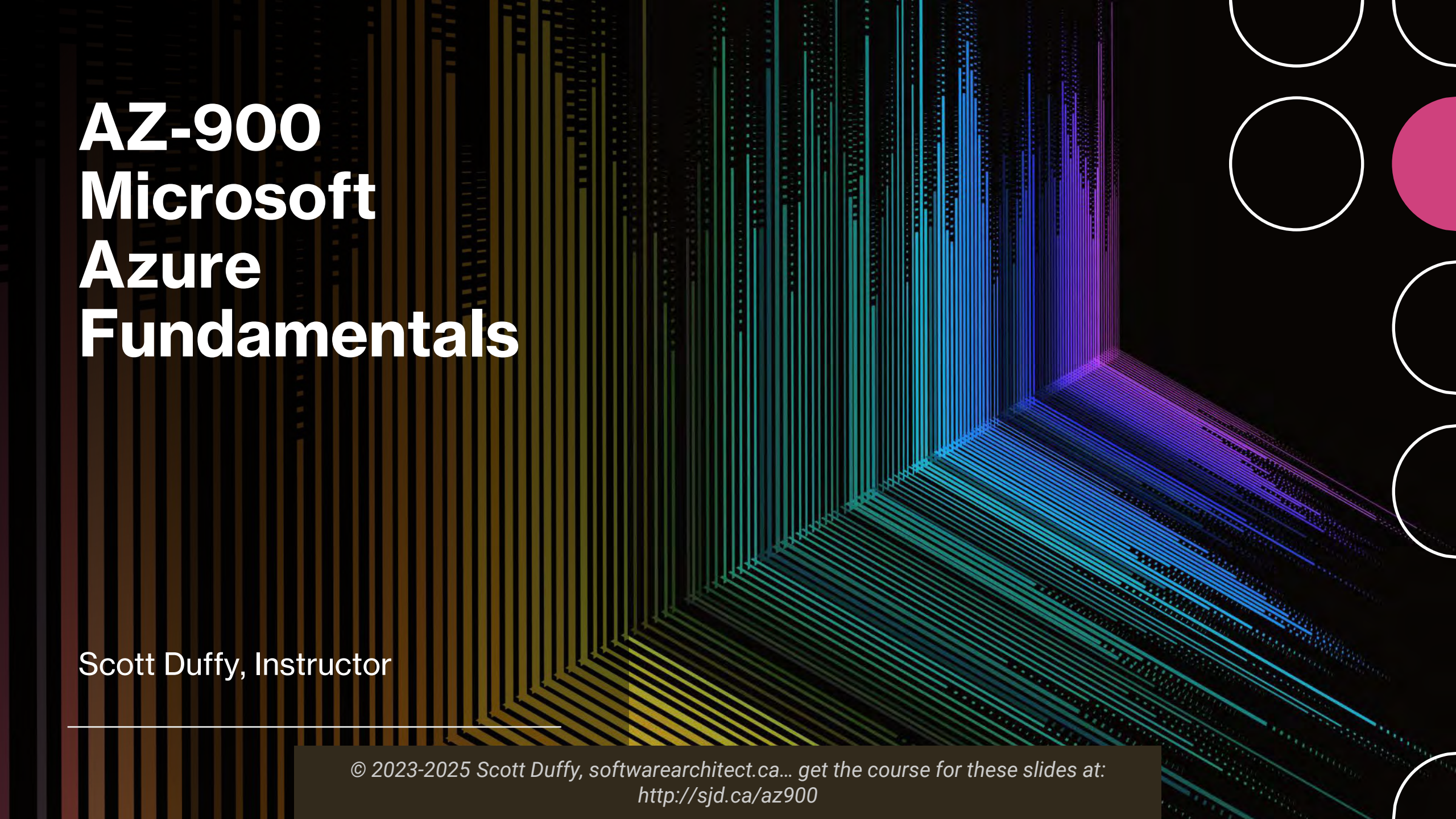

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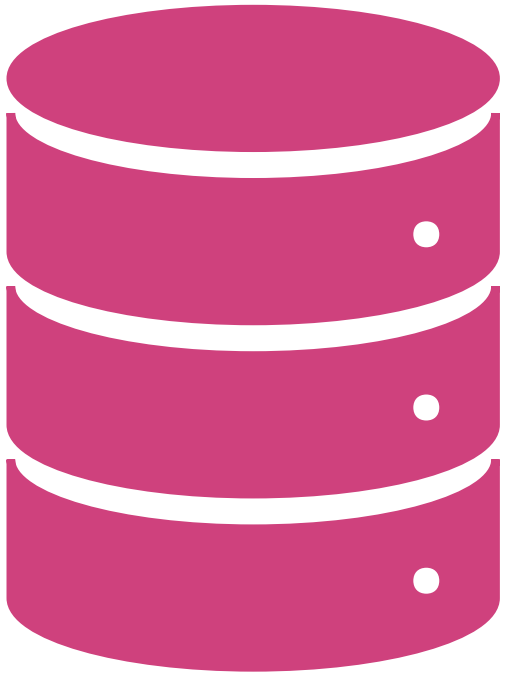
Infrastructure as Code (IaC)

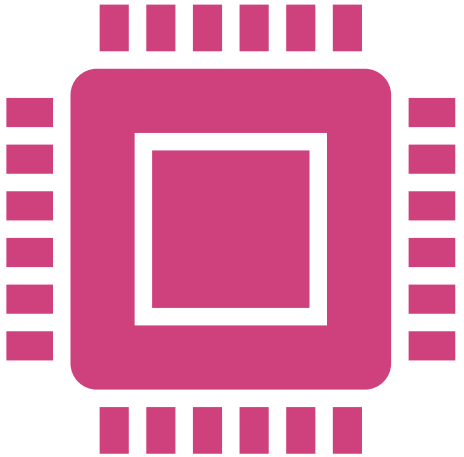


How do you “backup” your infrastructure setup?



Infrastructure as Code (IaC)

Define your desired infrastructure in a configuration file



And then you can re-deploy it again and again and again...

Recreate it in another region (duplication)

Desired state configuration (DSC)

IaC Options

- ARM Templates (JSON)
- Bicep
- Terraform
- Chef, Puppet
- PowerShell Scripts
- Other type of code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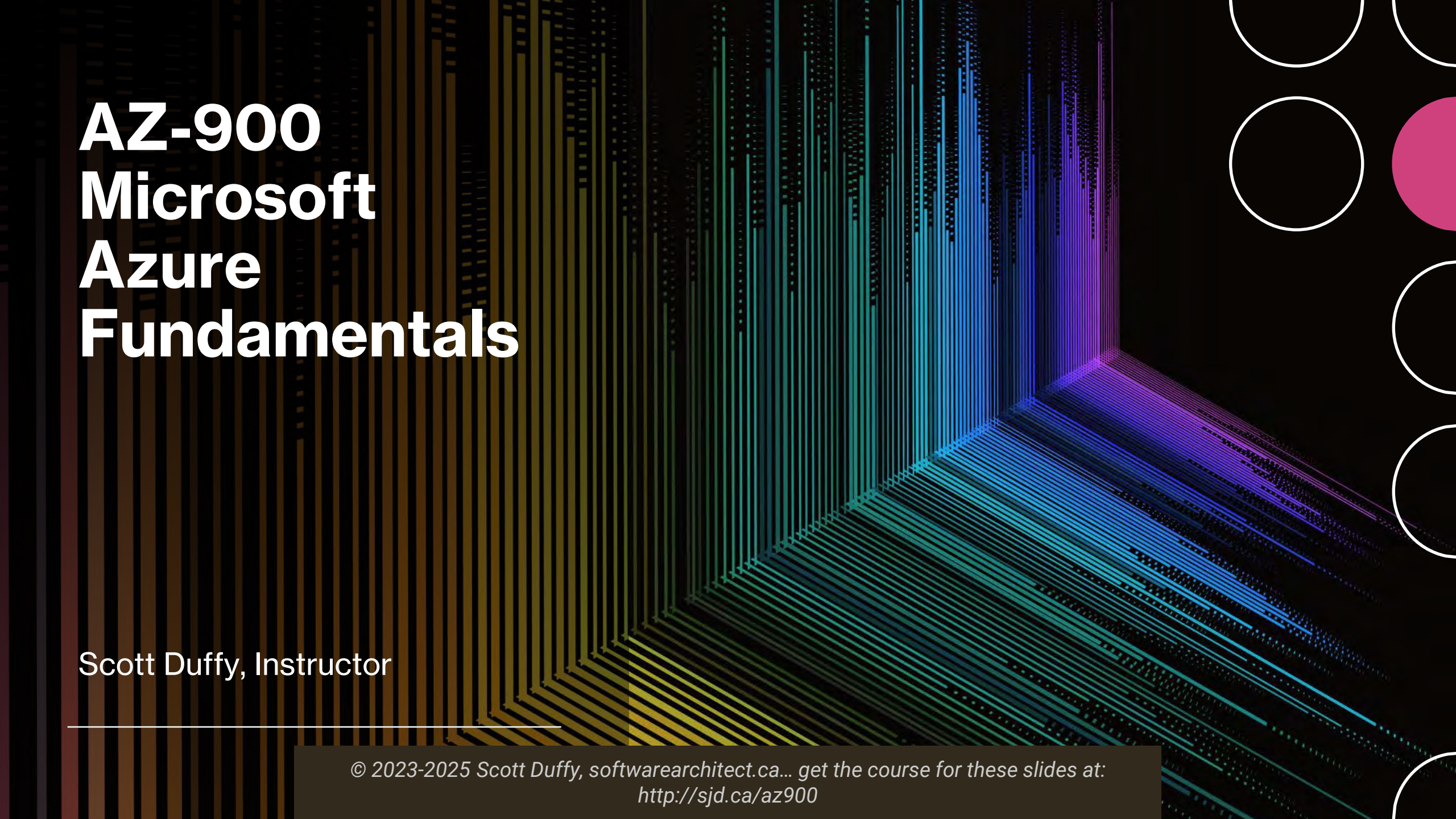

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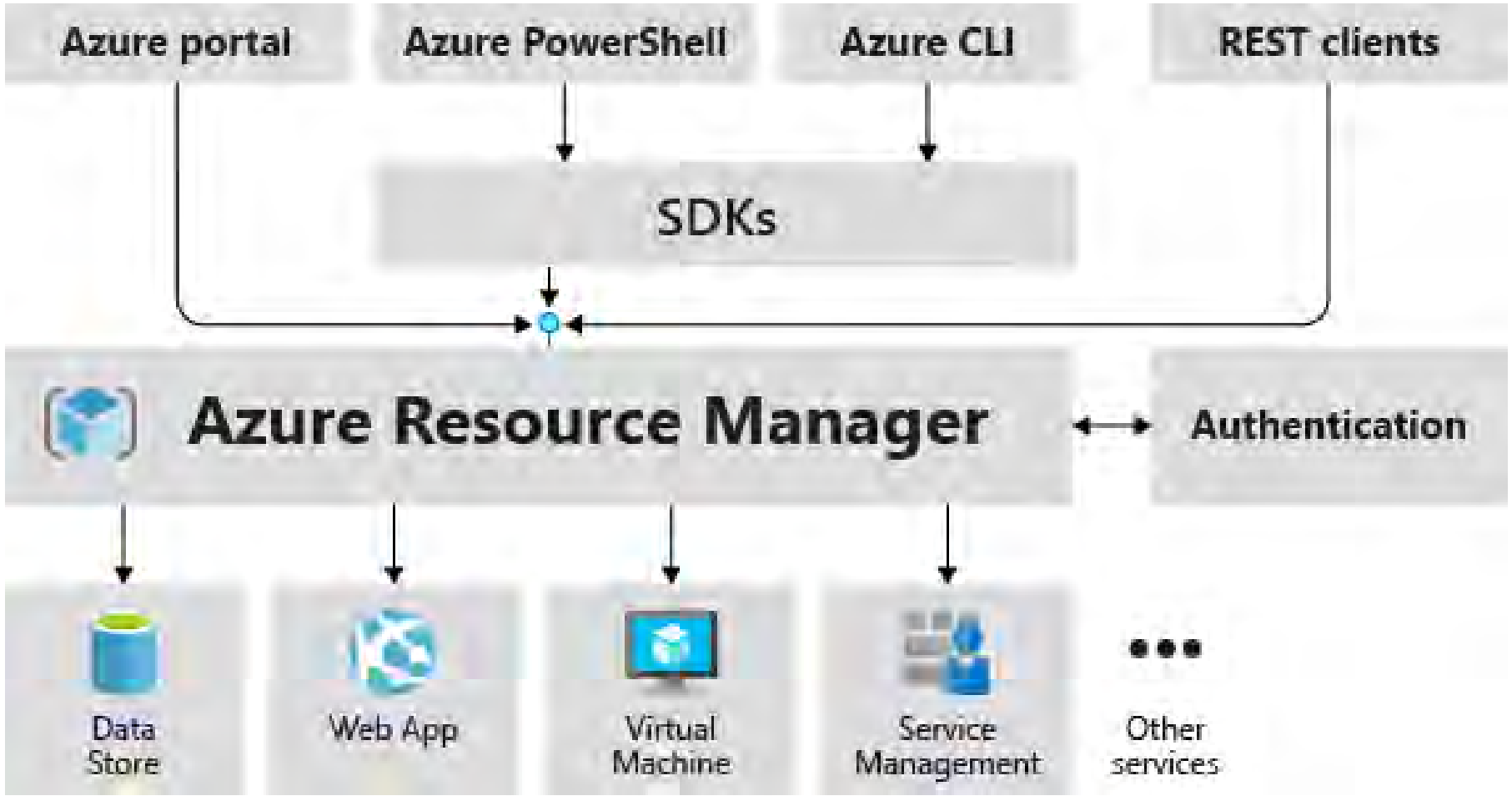
ARM Templates

Azure Resource Manager (ARM)

- The deployment and management service for Azure
- Management layer that allows you to create, update, and delete resources called “deployments”
- All actions that you take to manage your Azure resources goes through the ARM layer


Azure portal
Azure PowerShell
Azure CLI
REST clients
SDKs
Azure Resource Manager
Authentication
Data Store
Web App
Virtual Machine
Service Management
Other services

```
"resources": [
  {
    "type": "Microsoft.Storage/storageAccounts",
    "apiVersion": "2019-06-01",
    "name": "[parameters('storageAccountName')]",
    "location": "[parameters('location')]",
    "sku": {
      "name": "Standard_LRS",
      "tier": "Standard"
    },
    "kind": "StorageV2",
    "properties": {
      "accessTier": "Hot"
    },
    "resources": [
      {
        "type": "blobServices/containers",
        "apiVersion": "2019-06-01",
        "name": "[concat('default/', parameters('containerName'))]",
        "dependsOn": [
          "[parameters('storageAccountName')]"
        ]
      }
```

```
"resources": [
  {
    "type": "Microsoft.Storage/storageAccounts",
    "apiVersion": "2019-06-01",
    "name": "[parameters('storageAccountName')]",
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        "dependsOn": [
          "[parameters('storageAccountName')]"
        ]
      }
```


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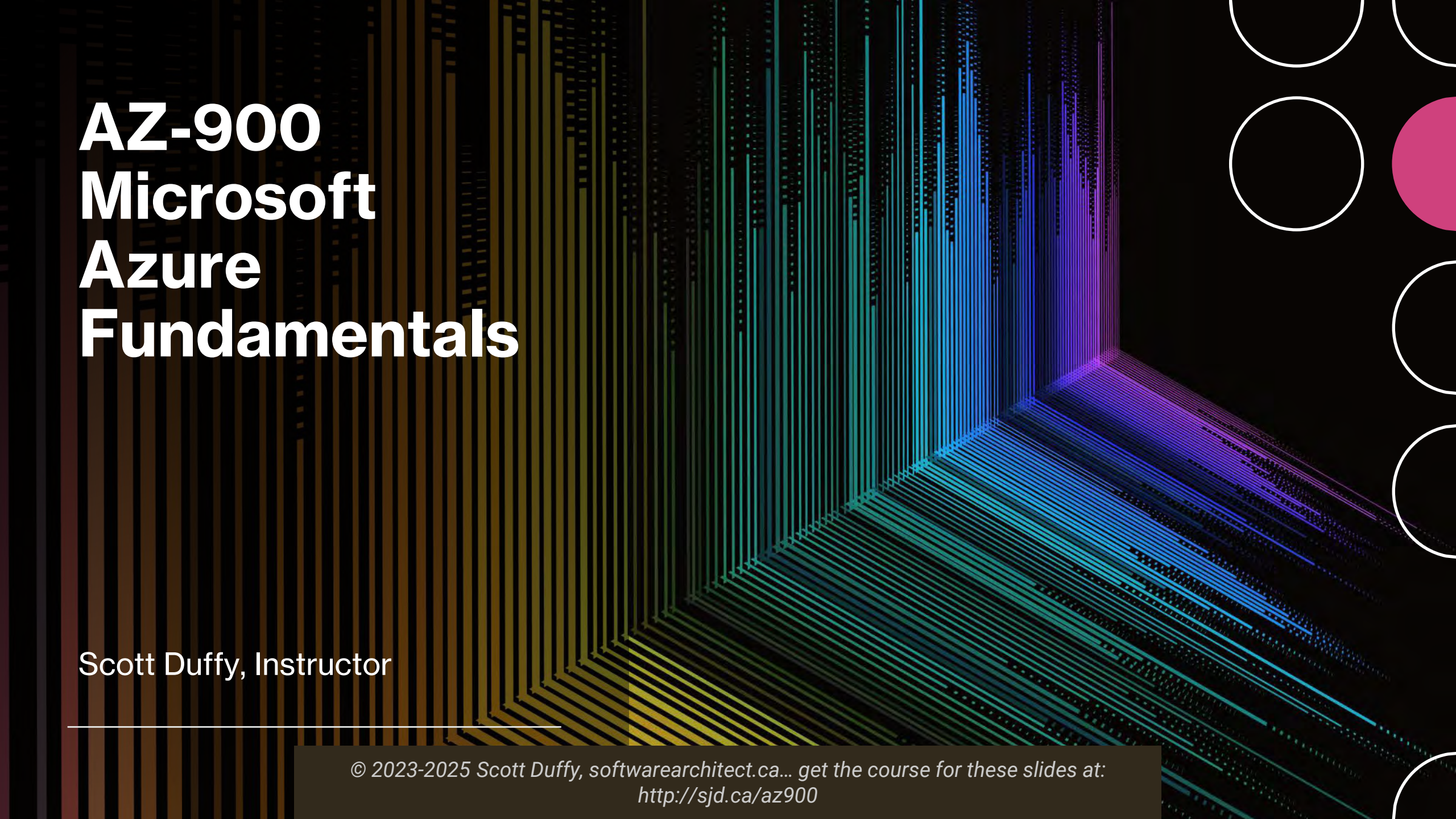

AZ-900 Microsoft Azure Fundamentals

Scott Duffy, Instructor

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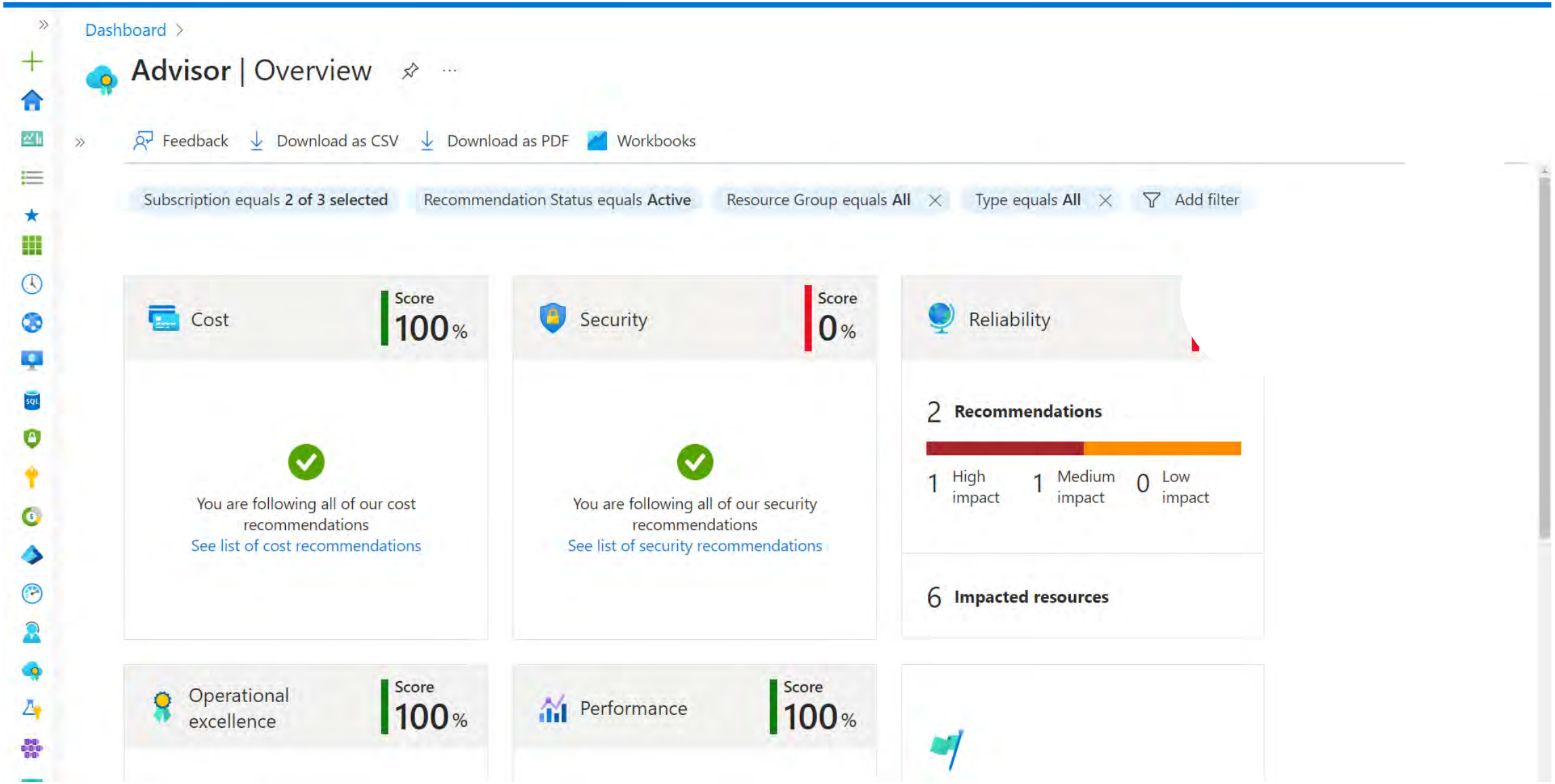
Describe monitoring tools in Azure

- Describe the purpose of Azure Advisor
- Describe Azure Service Health
- Describe Azure Monitor, including Log Analytics, Azure Monitor alerts, and Application Insights

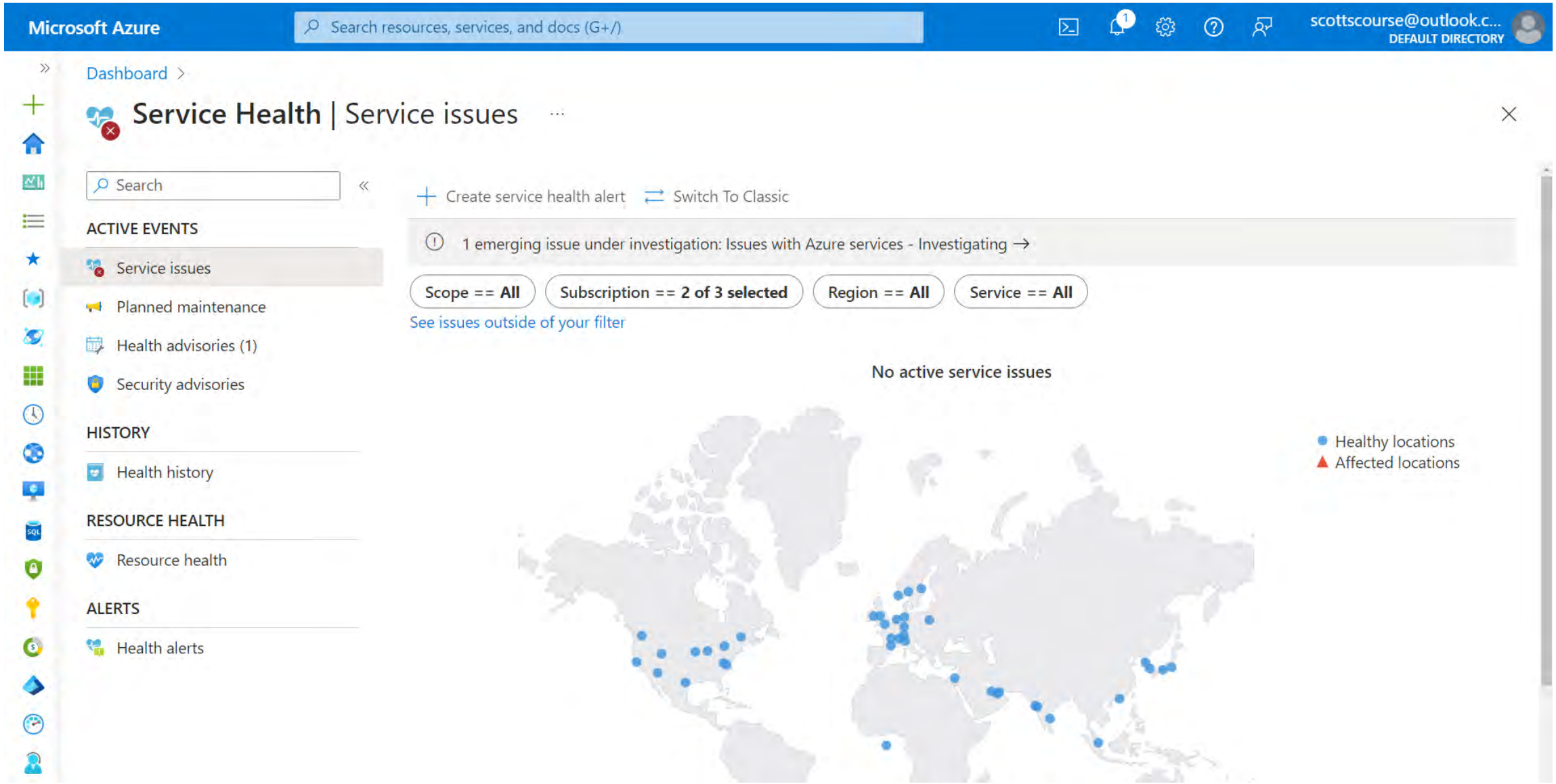
Azure Advisor

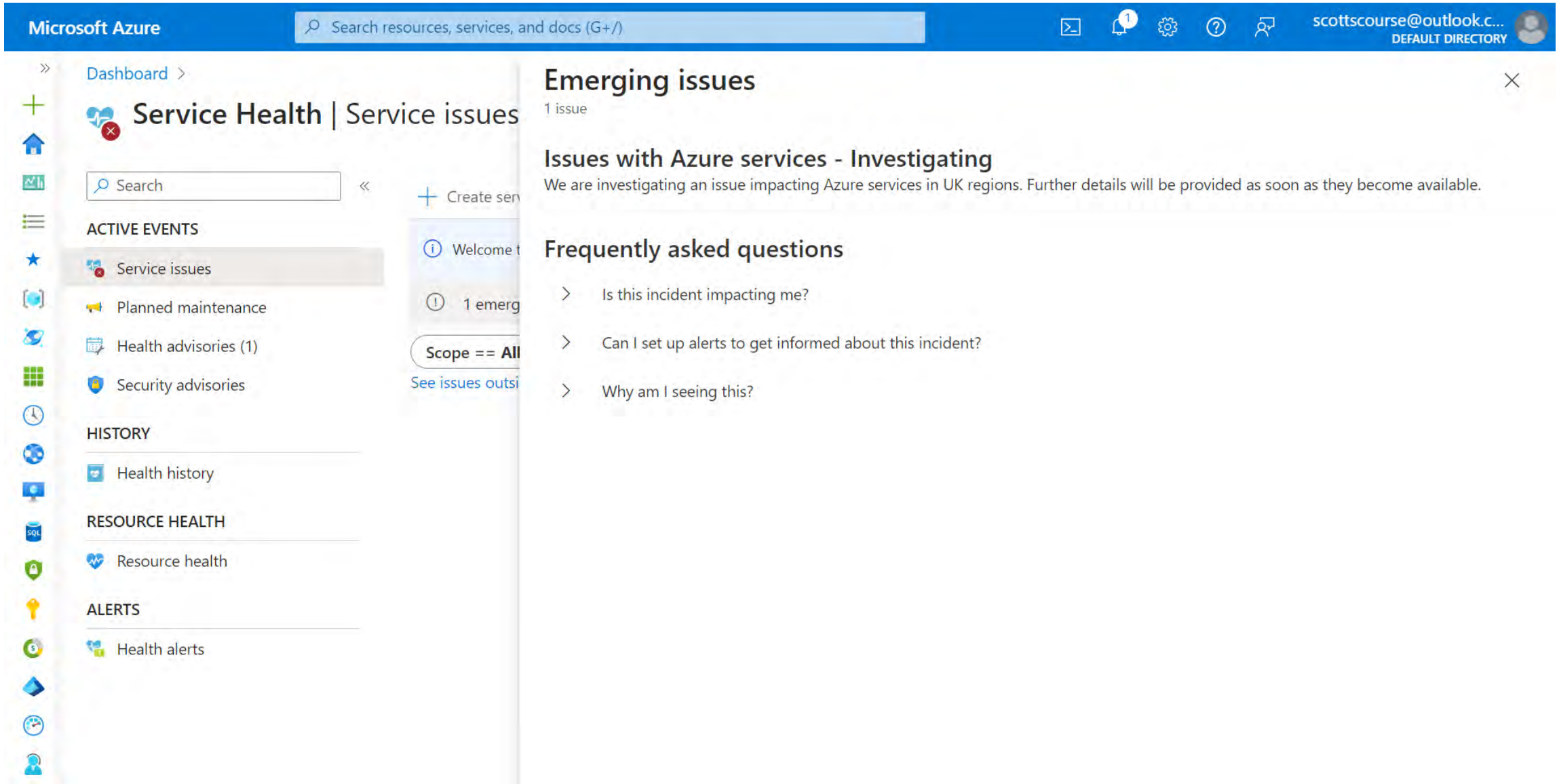



Dashboard
Advisor | Overview
Feedback
Download as CSV
Download as PDF
Workbooks
Subscription equals 2 of 3 selected
Recommendation Status equals Active
Resource Group equals All
Type equals All
Add filter
Cost
Score
100%
You are following all of our cost recommendations
See list of cost recommendations
Security
Score
0%
You are following all of our security recommendations
See list of security recommendations
Reliability
2 Recommendations
1 High impact
1 Medium impact
0 Low impact
6 Impacted resources
Operational excellence
Score
100%
Performance
Score
100%

Azure Service Health

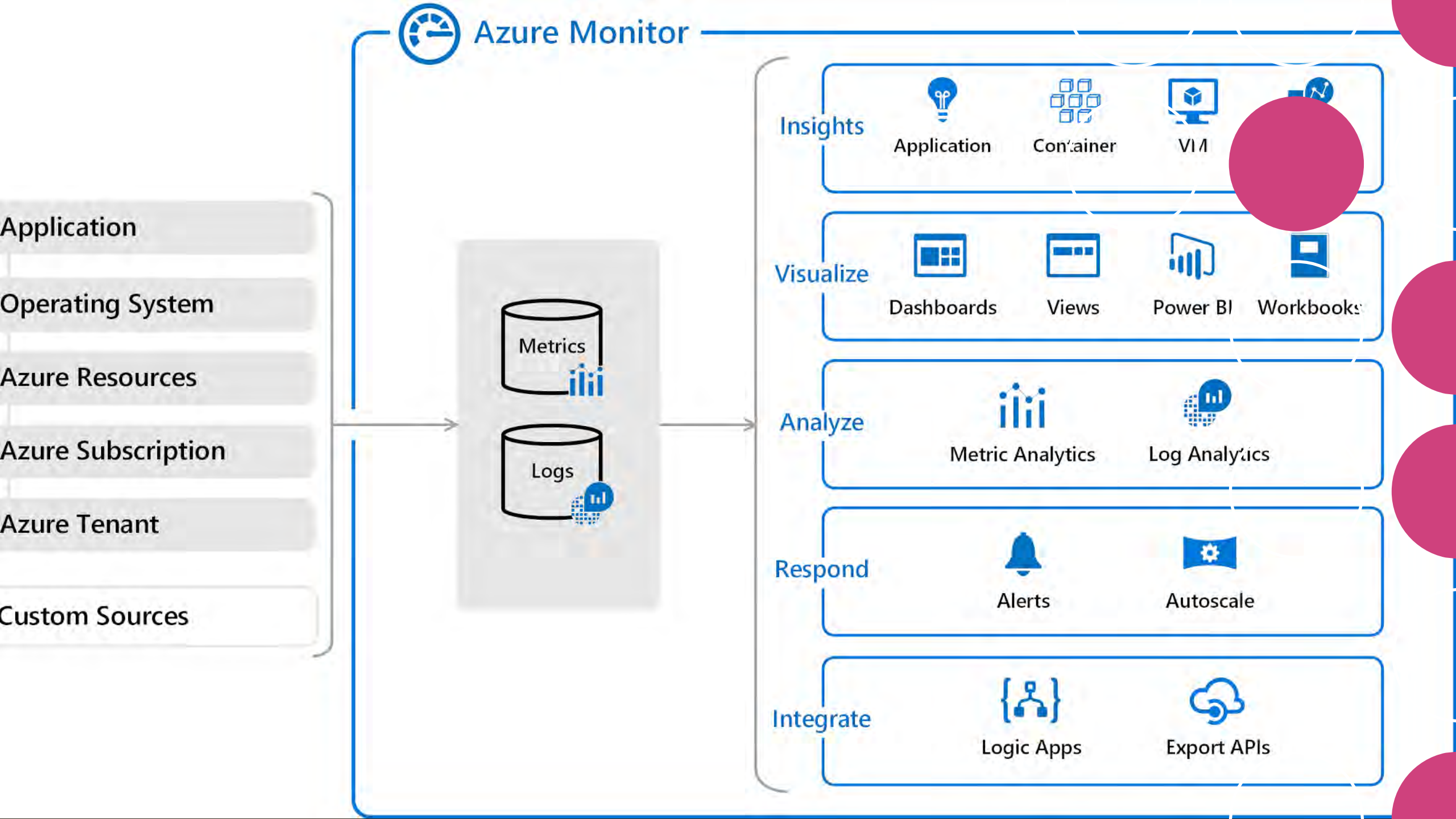



Microsoft Azure
Search resources, services, and docs (G+/)
scottscourse@outlook.c...
DEFAULT DIRECTORY
Dashboard
Service Health | Service issues
Search
ACTIVE EVENTS
Service issues
Planned maintenance
Health advisories (1)
Security advisories
HISTORY
Health history
RESOURCE HEALTH
Resource health
ALERTS
Health alerts
Create service health alert
Switch To Classic
1 emerging issue under investigation: Issues with Azure services - Investigating →
Scope == All
Subscription == 2 of 3 selected
Region == All
Service == All
See issues outside of your filter
No active service issues
Healthy locations
Affected locations


Microsoft Azure
Search resources, services, and docs (G+/)
scottscourse@outlook.c...
DEFAULT DIRECTORY
Dashboard
Service Health | Service issues
Search
ACTIVE EVENTS
Service issues
Planned maintenance
Health advisories (1)
Security advisories
HISTORY
Health history
RESOURCE HEALTH
Resource health
ALERTS
Health alerts
Create serv
Welcome t
1 emerg
Scope == All
See issues outsi
Emerging issues
1 issue
Issues with Azure services - Investigating
We are investigating an issue impacting Azure services in UK regions. Further details will be provided as soon as they become available.
Frequently asked questions
Is this incident impacting me?
Can I set up alerts to get informed about this incident?
Why am I seeing this?

Azure Monitor




Azure Monitor
Application
Operating System
Azure Resources
Azure Subscription
Azure Tenant
Custom Sources
Metrics
Logs
Insights
Application
Container
VM
Visualize
Dashboards
Views
Power BI
Workbooks
Analyze
Metric Analytics
Log Analytics
Respond
Alerts
Autoscale
Integrate
Logic Apps
Export APIs

Monitor | Overview

Microsoft

Search

Overview
Activity log
Alerts
Metrics
Logs
Change Analysis
Service health
Workbooks

Insights

Applications
Virtual Machines
Storage accounts
Containers
Networks
SQL (preview)
Azure Cosmos DB
Key Vaults

The Log Analytics agents, used by VM Insights, won't be supported as of August 31, 2024. Plan to migrate to VM Insights on Azure Mo... is date.

Overview | Tutorials

Insights

Use curated monitoring views for specific Azure resources. View all insights

Application insights

Monitor your app's availability, performance, errors, and usage.

View ··· More

Container Insights

Gain visibility into the performance and health of your controllers, nodes, and containers.

View ··· More

VM Insights

Monitor the health, performance, and dependencies of your VMs and VM scale sets.

View ··· More

Network Insights

View the health and metrics for all deployed network resources.

View ··· More

Detection, triage, and diagnosis

Visualize, analyze, and respond to monitoring data and events. Learn more about monitoring

Metrics

Alerts

Logs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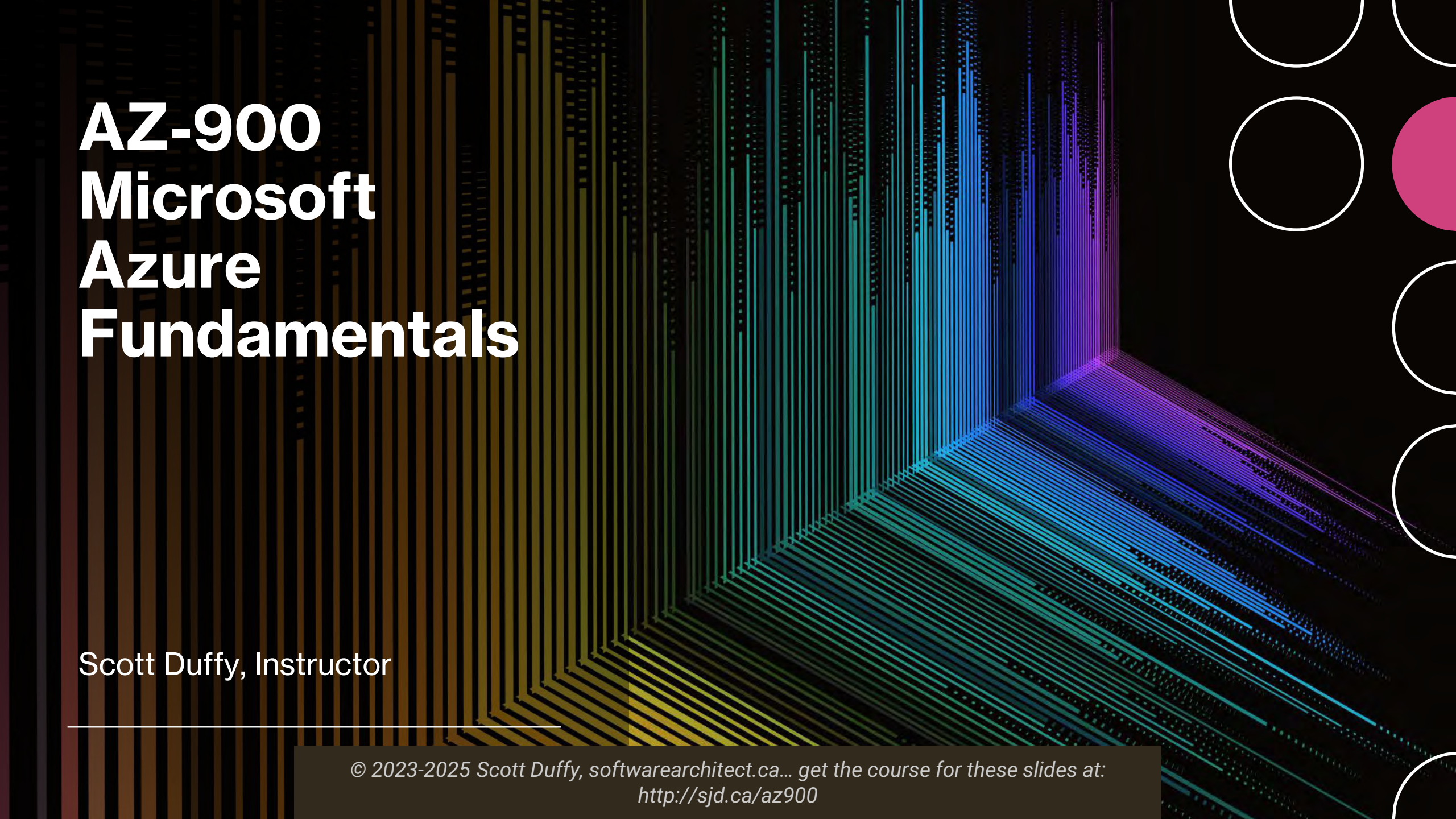

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Thank you and best of luck!

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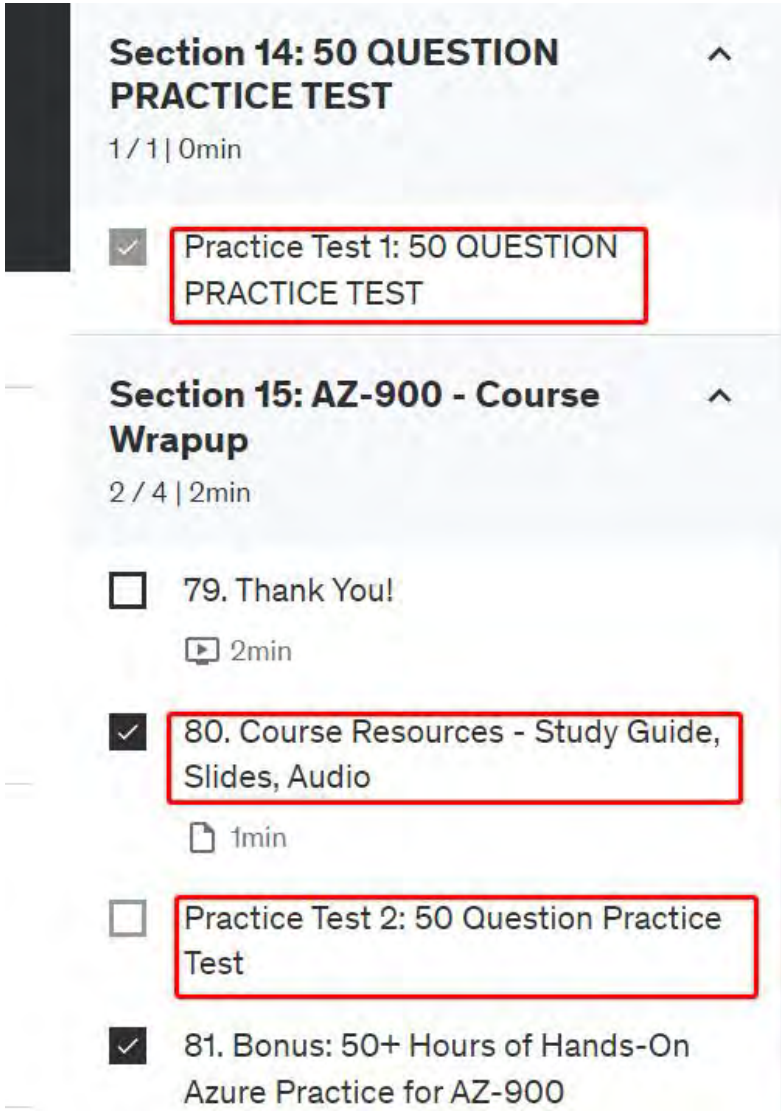
  - Free PDF Study Guide
  - Download the slides and MP3 audio
  - if you like to study offline
  - Two 50 question practice tests

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